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Morse Telegraph Tutor.

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BEING

A MANUEL OF

TELEGRAPHY

FOR

Railway Signallers.

BY

P. J. RUSSELL,

TELEGRAPH INSTRUCTOR,

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THE

MORSE TELEGRAPH TUTOR.

* * *

INTRODUCTORY REMARKS.

Any person, young or old, can learn Telegraphy, and become a good signaller, but, as a rule, the best time is between the ages of fifteen and twenty-five years. The operation of telegraphy is not, as many people suppose, a complicated or difficult matter to understand. The apparatus employed is quite simple and easily understood.

The great extension of telegraphic system throughout the Indian Empire and the Native States is creating employment for thousands of telegraph signallers each year in addition to those already in the service.

The salary paid to a signaller in India varies according to his skill and the size of the office where engaged.

The usual course of a signaller's progress is as follows :—

First, just after passing the signallers' test he may obtain a situation in some small office, which may either be a third or second class office in a city or a small provincial town.

The next step in advance is to a larger office or more important station where there is a greater amount of telegraphing to be done and more skillful signallers required. From here, and further on, the signaller who acquires skill by close attention and continual effort to improve, wherever he may be in these more important situations, is soon business, always find employment in any large city or important telegraph centre.

The one rule which will never fail to enable a person to become a successful first-class telegraph signaller is—"Practise constantly and inform yourself on every practical point connected with the apparatus and operation of the telegraph."

From four to six months' steady practice is usually sufficient to enable a person to become competent to take charge of a small telegraph office.

From one to two years' experience in actual telegraphing will enable almost anyone to become a first-class signaller if proper diligence is exercised.

It is always much easier for a good signaller to obtain a situation at the regular rate of pay for first-class skill than it is for a third or fourth-rate signaller to procure employment, even at the lowest rates.

The fact is that at this present time (1907) the subject of Electricity, in its many new and wonderful applications, is the foremost study of intelligent mankind throughout the world, will add interest to the effort of the student who seeks to become familiar with electricity as applied to telegraph.

To learn in a short time to read and send the Morse Alphabet requires almost continual practice. For this reason it is a great advantage to students of Telegraphy to possess a small dummy key upon which they may practise anywhere in leisure hours which they may have.

The dummy key is not intended to take the place of the Morse instrument and Battery, because after the student has become proficient in reading and sending the alphabet, it is still necessary to use the Battery Instrument for practice at sending and receiving where the sender and receiver are in separate rooms or at a greater distance apart with the Morse Instrument in connection by wire.

But the dummy key is a valuable assistance in the beginning to

CHAPTER I.

PRELIMINARY.

ELECTRICITY—Like wind, is a natural power which cannot be seen but we know its existence by the effects it produces, such as deflecting a magnetised needle or working a telegraph instrument, etc.

2. ELECTRIC CIRCUIT—Is the path of electric current, it consists of a battery and everything between its poles. It always forms a closed loop or ring. When a current is passing through the circuit it is said to be complete or closed.

3. When the continuity of the conductors is broken, the current stops and the circuit is said to be broken or open.

4. CONDUCTORS—Are substances which offer a free passage to electric currents : such as metals, damp earth, water, living vegetables or plants and living animals.

5. CONDUCTORS—Supported by a non-conductor is said to be insulated.

6. NON-CONDUCTORS or INSULATORS—Are substances which obstruct the passage of electric currents : such as silk, India-rubber, ebonite, dry air, paper and dry wood.

7. METALLIC CIRCUIT—By which is meant one of which the earth does not form a part, being made wholly of metal.

8. ELECTRIC CURRENT—Is a continuous flow of electricity from positive to negative caused by a maintained difference of potential between one point and another, and once set up it does not stop until the potential is equalised.

9. Volta said that the current was due to contact of dissimilar metals, and Galvani to chemical action. Both these causes, however, exist in the battery and both produce difference of potential.

10. POTENTIAL—In its widest sense signifies "Power to do

be spent upon a unit of positive electricity in bringing it up to any point from an infinite distance. It is often said that potential is to electricity what level is to water, and just as it is convenient to consider "sea-level" as a zero point from which to measure heights or depths, so in measuring difference of potential or difference in electrical level, the surface of the earth, which is always slightly electrified, is considered for the time being as an arbitrary zero point. No electric current can flow anywhere without a difference of potential and without electromotive force.

11. ELECTRO-MOTIVE FORCE—Is that power which overcomes resistance and moves the current from one point to another and is due to electrical pressure caused by difference of potential.

12. RESISTANCE—Is the obstruction which the current meets in its path over a conductor ; the strength of the current, therefore, depends on the resistance which it meets and overcomes in its path in exactly the same manner as the amount of water that runs through a pipe depends on the resistance it meets with ; for, if the pipe be very thin or choked with sand the water will run through in small quantity because the space within the pipe is small which obstructs the flow of the water ; but if the pipe be a thick one and not choked with sand, the water will freely run through in large quantity because the space within is large and the obstruction or resistance small. The better the conductor the less the resistance, the worse the conductor the greater the resistance.

Metals in general conduct well, but thin long metal wires will offer a great resistance and allow only a feeble current to pass through them.

The resistance of the wire therefore depends on its length and thickness, that is to say, upon the specific resistance of the material.

13. CONDUCTIVITY.—This term is sometimes used as the inverse of resistance ; thus, conductivity and resistance are reciprocals of one another, and the reciprocal of a number being unit or one divided by that number, the conductivity of a conductor whose resistance is

14 The AMPERE—Means unit quantity of current.

15. The VOLT—Is the unit by which difference of electrical potential or electro-motive force is compared and is equal to the Electro-motive force of one Minotto cell.

16. The OHM—Is the unit for measuring resistance and is equal to the resistance of 129 yds. of copper wire $\frac{1}{16}$ inch in diameter.

If a current of 1 Ampere at a pressure or electro-motive force of one Volt is delivered at one end of a copper wire 129 yds. long × $\frac{1}{16}$inch diameter no current would result at the other end because the resistance would counterbalance the energy.

17. EARTH CURRENTS—Are natural currents due to difference of potential between the earth at two stations or two different points on the line ; it is also caused by passing clouds. They strengthen or weaken signalling currents according as their direction is the same or contrary to that of the battery currents.

18. A MAGNET—Is a piece of iron or steel which will attract other pieces of iron or steel and make them magnet also, and if freely suspended will point north and south.

19. An ELECTRO-MAGNET—Is a magnet only as long as the current passes through the coils of silk-covered wire with which it is wound ; its cores are made of soft iron.

20. A PERMANENT MAGNET—Is always a magnet.; it is made of hard steel.

Every magnet has at least two poles which are named north and south, respectively, from the direction in which they point when the magnet is on a pivot.

21. Like poles of all magnets repel one another, and unlike poles attract one another.

22. If a piece of soft iron be placed on the north or south pole of a permanent magnet the iron will become an induced magnet.

CHAPTER II.

PRINCIPAL OF ELECTRIC TELEGRAPH.

23. In general, the material requisite for working by Morse Telegraphy are as follows :—

I. Transmitting key for sending signals.

II. A Battery which supplies electric currents.

III. Line Wire which conducts the currents from one station to another.

IV. A Lightning Discharger at each station for protecting telegraph instruments from damage by lightning.

V. A Sounder or Relay with sounder combined for receiving the signals sent from one station to another.

VI. Earth for completing the path of the sent current.

VII. Short Circuiting Bell for calling attention of the signaller on duty.

VIII. A Switch for making certain connections quickly.

IX. A Magnetic Indicator for indicating the presence of currents passing through the receiving instrument.

24. The system generally employed in India for Railway Telegraph is that known as the "Closed Circuit System" for "Through," "Main" and "Inter Wires" and "Open Circuit System" for Train wire always.

25. The Morse signals are sent by a simple key, which the signaller depresses when he wishes to send a current, and raises when he wishes to stop it.

26. A short depression or a mere tap sends the short elementary signal called a *dot ;* a longer depression sends the second elementary signal called a *dash.* The Morse Alphabet is formed by a combination of

ed by longer pauses and words by still longer intervals, as explained hereinafter.

CHAPTER III.

COURSE OF INSTRUCTION.

27. The course may be described as composed of three parts :—

I. Sending and Receiving of Morse signals.

II. Instrument Technicals.

III. Traffic Rules.

28. The first part consists of three practices, *viz.* :—

I. Morse sending with the key and without a companion student.

II. Combined Morse sending and reading with a companion student.

III. Practice in both Morse sending and reading of messages, test pieces made up of printed matter containing 80 or 100 five-lettered words with ten per cent (10%) of figures and social conversations where two or more persons practising are in separate houses or rooms and entirely dependent upon the wire and instruments for their communication with each other.

PRACTICE I.

29. When the letters of the alphabet are signalled, two elements

30. Learning the Morse Alphabet consists of three stages :

Firstly, impressing on the mind the particular combination of elements of which each letter is composed.

Secondly, becoming proficient in grasping the letter as a whole.

Thirdly, reading two or more letters together.

31. POSITION & MOVEMENT.—Place the first and second fingers on the top of the key-knob the thumb under the edges, curve the first and second fingers so as to form the quarter section of a circle, place the elbow and arm in level with the desk and let the wrist be perfectly limber.

32. Grasp the key-knob firmly but not rigidly, never allow the fingers or the thumb to leave the key-knob ; avoid too much force or too light a touch, and strive for a medium firm closing of the key contacts.

33. The motion to be given to the hand is directly up and down, never allow the wrist to rest on the desk, and when the hand is in motion carefully avoid all side and contorting pressure. The wrist only should go up and down when in motion, for which reason the wrist must be kept perfectly elastic. The fingers, wrist and arm should move uniformly in the same direction.

34. The downward movement produces the dots and dashes and the upward breaks and spaces.

35. Learn to use the key by making dots in succession at the rate of two every second and increase the speed five-fold as skill is acquired. Continue to practise dots until 360 per minute can be made with perfect clearness, ease and regularity.

36. When dots can be readily made as directed, begin with dashes at the rate of two every three seconds, and gradually increase speed until 120 per minute can be made with perfect regularity and ease.

37. When dots and dashes can readily be made with perfection, begin to learn the Morse Alphabet, numbers and punctuations, one at

of them can be made without hesitation and correctly, *i. e.*, with proper space (or break as it is called) between the elements of which it is composed.

38. In the first stage the phonetic method may be employed, by which each letter is presented to the ear, in the form of short and long sound is built of the signalling elements composing it thus the Dot of the letter E would sound " Diddle " or Dash of the letter T would sound " Dumpty" and Dot Dash of the letter A would sound "Diddle Dumpty."

39. Good sending and therefore easy reading depends upon the accuracy with which the correct lengths of the "Dots" and " Dashes " and of the separating intervals commonly called "Spaces" are maintained as explained below :—

(*a*) The unit of length of the signal forming the Morse Alphabet is the Dot.

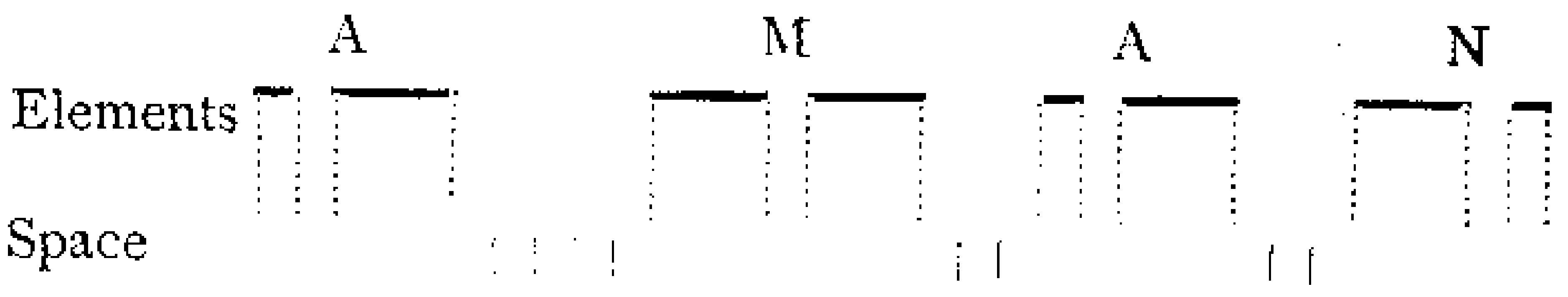
(*b*) The space between the signals forming part of the same letter is one unit equal to one Dot.

(*c*) The length of Dash is three units equal to a Dot, a Space, and a Dot.

(*d*) The space between two letters is three units equal to the length of a Dash.

(*e*) The space between two words is five units equal to a Dash a Space and a Dot.

The above rules are illustrated by the words, "A Man."



THE MORSE ALPHABET.

A – —
B — – – –
C — – — –
D — – –
E –
F – – — –
G — — –
H – – – –
I –
J – — — —
K — – —
L – — – –
M — —
N — –
O — — —
P – — — –
Q — — – —
R – — –
S – – –
T —
U – – —
V – – – —
W – — —
X — – – —
Y — – — —
Z — — – –
Ch — — — —
é (French) – – — – –

UNUSUAL LETTERS.

Ä (æ) – — – —
Ñ (Italian) — — – — —
Ö (œ) — — — –
Ü (ue) – – — —

FIGURES.

1 – — — — —
2 – – — — —
3 – – – — —
4 – – – – —
5 – – – – –
6 — – – – –
7 — — – – –
8 — — — – –
9 — — — — –
0 — — — — —

Bar of division for fraction (as in $\frac{1}{4}$ or 1/4) — —

ABBREVIATED NUMERALS.

(*For use only in the repetition of figures which immediately follows the signalling of a message*)

1 – ——
2 – – ——
3 – – – ——
4 – – – – ——
5 – – – – –
6 —— – – – –
7 —— – – –
8 —— – –
9 —— –
0 ——

Bar of division —— ——

PUNCTUATION AND OTHER SIGNS.

Full stop (.) – – – – – –
Comma (,) – —— – —— – ——
Semicolon (;) —— – —— – —— –
Colon (:) —— —— —— – – –

Note of interrogation (?) or request for the repetition of anything transmitted which is not understood – – —— —— – –

Note of exclamation (!) —— —— – – —— ——
Apostophe (') – —— —— —— —— –
Hyphen or Dash (--) —— – – – – ——
Double dash (=) —— – – – ——

Parenthesis [( )] (signalled before and after the words placed between. Also signalled before and after letters affixed to figures but it is not written down) —— – —— —— – ——

Inverted commas (" ") (signalled before and after the words placed between) – —— – – —— –

Underline (signalled before and after word or sentence underlined) as in come sharp business urgent – – —— —— – ——

Attack or Call-signal (preliminary to every transmission)

—— – —— – ——

Request to transmit or go on ——— — ———

Signal of separatian (signalled between Preamble and Address and Address and Text of message and also between text and Sender's name in the case of a Foreign message if the sender's name is to be signalled ——— — — — ———

Error, erasure, or rub out — — — — — — — —

Finis or end of telegram — ——— — ——— —

Cross × (to be signalled before and after words and group of figures which count as two) as in all-right and 15—17—20—40 — ——— — ———

New paragraph or begin another line — ——— — ——— — —

End of work (clear) — — — ——— — ———

Wait — ——— — — —

PRACTICE II.

40, This practice consists in alternate key sending by one student while the other practises at reading the words that are sent and in copying them (letter by letter immediately it is signalled and shifting the pencil for space as each word is completed) as far as possible.

41. WORDS.—The student may now arrange series of words and figures such such as :—

Apples 123.
Birds 456.
Coats 719.
Ducks 901.
Eggs 787.
Fruits 634.
Grapes 432.
Hens 109.
Idols 287.
Jews 787.
Kerchief 1st.
Ladder 2nd.
Magnet ¼.
Natural 5, 7.
Ozone 5-2.
Phenomenon 5·3.
Quotation 19·7.
Reaction %.

42. Considerable training at this work is necessary to enable the student to become thoroughly familiar with the sounds of the Morse letters and figures as made by each other to read what is sent with the key.

43. BAD SPACING.—If the student has a tendency to make his letters in piece meal or in parts, he should at first dwell slightly upon any dash element of a letter giving him trouble, so that he can make up his mind while the lever of the key is depressed how he will send what follows.

44. EXAGGERATION.—If the student has got into the bad habit of exaggerating that is of sending indefinite number of dots for an H, 5, &c. and extra dots or dashes in such letters and figures as B. D. V. 4, 2, 3, &c. he should strive to get rid of it quickly by sending slowly, steadily and counting at the same time the dots and dashes of the letter or figure in which he makes a mistake until the correct number of dots or dashes are signalled; when he should repeat it and bring up the speed gradually as skill to send correctly is acquired. Cultivate a firm, even, smooth style of sending and carefully avoid rushing one letter into another or in other words joining the elements of one letter with another which follows it.

45. Always send the following signal before you commence to send anything :—

(Attack) —— - —— - ——

46. When a mistake is made or a letter is made wrong give the following signal :—

(Rub out) — — — — — — — —

and commence again with the last word made correctly; and at the end of the transmission give the following signal :—

(Finis) — —— — —— —

47. After a fortnight the student should commence the 3rd

PRACTICE III.

48. This practice is the last and most interesting step in learning telegraphy and in preparation for the duties of a telegraph signaller. It consists of sending and receiving of printed matter for speed exercise, and sending and reading of telegrams of about 20 words, social conversation and practical instructions in booking, re-addressing reporting non-delivery of telegrams, and preparation of weekly returns, for learning telegraph office routine work.

49. The practical work mentioned above will be varied by lectures on the care of instruments battery, and their faults and remedies, but the telegraph student should practically carrying out the following exercises :—

(i) Adjusting of a D. W. Sounder and S. R. Bell.

(ii.) Cleaning of instruments.

(iii.) Connecting instruments for both "Open" and "Closed" circuit working.

(iv.) Tracing faults previously put on by the instructor and restoring commnnication.

(v.) Sending and receiving of telegrams.

50. SENTENCES FOR SPEED PRACTICE.—The student may take such sentences as he likes containing 80 five-lettered words with 10 per cent of figures, this is done by cutting a piece of printed matter from a newspaper having 360 letters which is pasted on to a piece of white paper, after which 24 figures including a few of the punctuations, such as comma, hypen, decimal, bar of division and letters affixed to figures forming ordinal numbers are added in group of 3, 4, or 5 figures in manuscript.

51. WORKING SIGNALS.—The following authorized abbreviations are in use to denote certain phrases and words which are in constant use between telegraph signallers in signal offices connected with the message work to save time :—

Send attack to enable me to adjust my instrument

Your instrument is out adjust I will send attacks	Aj.
All-right	Rt.
Go on	K.
May I go on ?	Gn.
Acknowledge receipt of	Ack.
Have you any message for me	A.
No	N.
Ditto	D.
I have a line clear message for despatch to you	R. R. R.
Stop working for "Danger" message	D. D. D.
Stop working for "Clear the line" message	O. O. O.
Signal fast or faster	Ff.
Signal slowly or more slowly	Sl.
„ Steadily	Sty.
Beats bad	Bt. B.
How are beats	Bt ?
Beats good	Bt. Gd.
Beats weak	Bt. Wk.
Beat imperfect	Bt. Imp.
What station are you	Stn?
Say when you are ready	Rq.
How many messages have you got	H. M.
My pencil is broken, let me mend it	Pen.
Use carbonic paper	Car.
Is it a received message	Car ?
It is a transit message, dont use Carbon	Trs.
Use large form the message contains over 32 words in the text	Lf.
Why no answer	Y. N. A.
Call Telegraph-master	C. T. M.
„ Post-master	C. P. M.
„ Station-master	C. S. M.
„ In-charge or Hd. Signaller	C. I. C.
Your letter No. 16 of 10th or your telegram of 16 words of 10th	16-10

Your telegram of 16 words, dated 10-15 hours of to-day	16-10-15
Are	R.
You	U.
Are you ready	Rud.
Wait	- — - - -
Want 5 minutes	- — - - -5 mts.
Why	Y.
Working	Wkg.
Stop sending	- - — - - — - - —
Leave the instrument alone	L. I. A.
Join	Jn.
Join direct	Drt.
Join in translation or T working	Trs.
Join in P working	Pll.
Joined	Jd.
Message	M.
Messages	Ms.
Instrument	Inst.
Number	No.
Local number	Ln.
To (in address)	T.
From (in preamble and address)	F.
Official instruction	O. I.
More	M.
Short	S.
Words	Wds.
Number of words (in Preamble)	W.
Word after	WA.
Word before	WB.
Please	Pl.
Thanks	Tks.
Your	Ur.
Hour	Hr.
Minute	Mt.

Closed Circuit — — — — Cld. Crc.
Train Wire — — — — TS.
Main Thro. Wire — — — MT.
Through Wire — — — — Th.
Intermediate Wire — — — Inter.
Rain — — — — Rn.
Raining — — — — Rng.

52. There are two sorts of telegrams sent and received in India which are known as Inland telegrams and Foreign telegrams. And they are each divided into four kinds, *viz* :—

(*a*) State (or Government) telegrams.
(*b*) Service telegrams.
(*c*) Private telegrams.
(*d*) Press telegrams.

All these telegrams are transmitted according to their classification:—Urgent, Ordinary or Deferred and in the order in which handed in at the telegraph office of origin.

*53. CLASS CODES :—The first signal sent in a message after having obtained the attention of the distant station is called "Class code" or "Prefix" it enables the signaller to know the class and the kind of message about to be signalled.

Prefixes :—

(i) Urgent foreign state telegram ... ... XFS
Urgent state telegram (Inland) ... ... XS
Ordinary state telegram do. ... ... S
Deferred state telegram do. ... ... DS

(ii) Urgent foreign free telegraph Service ... XFT
Urgent telegraph Service (Inland) ... ... XT
Ordinary telegraph Service do. ... ... T
Deferred telegraph Service do. ... ... DT

(iii)	Danger Railway Service (over Railway wires)	DDDR
	,, ,, ,, (when sent over Govt. wires)	XXR
	Ordinary Railway Service	R
	Deferred Railway Service	DR
(iv)	Urgent foreign private telegram	XFP
	Urgent private telegram and paid service advice (Inland)	XP
	Ordinary private telegram and paid service advice do.	P
	Deferred private telegram and paid service advice do.	DP
(v)	Urgent Inland press telegram	XNP
	Ordinary ,, ,,	NP
	Deferred ,, ,,	DNP
(vi)	Foreign paid service advice	XST
	Urgent Telegraph money order telegram	XMO
	Deferred Telegraph money order telegram	DMO
	Confirming Service to collated message, (prefixed) to State and Private class codes	C
	Inland advice of delivery private telegram	CR
	Inland advice of delivery state telegram	CRS
	Foreign advice of delivery private telegram	XCR
	,, ,, ,, state ,,	XCRS
	Urgent prefixed to an S, T, R, or P message showing that the message bearing it is to be signalled before ordinary messages ...	X
	Deferred prefixed to an S, T, R, or P message showing that the message bearing it is to be signalled after ordinary and urgent messages...	D
	Foreign (the message bearing it is to be signalled before all Inland urgent messages in the following order :—(1) State ; (2) Service ; (3) Private ; (4) Press	F

STANDARD CODE TIME.

54. While precedence among different classes of telegrams is determined by the Prefix or Code class, the order of transmission among telegrams of the same class and character must also be determined. *For instance, a Central Telegraph Office* may be in communication with several others and receive two or more telegrams with the same "Class-codes" for transmission along the same circuit. These must be despatched according to the *priority of their code time.*

55. This code time represents the hour at which the telegram was handed in by the sender at the *telegraph office of origin.*

56. The Standard time which is 5 hrs. 30 mts. in advance of Greenwich time is the *time utilized in Telegraph offices* in booking telegrams, etc., and it is reckoned from O hour (midnight) to 24 hours. The student should not call the hour after mid-day 1 p.m., 2 p.m., but say 13 hours, 14 hours and so on, and likewise *the minutes after 24 hours should not be written down* as 24 hours, 1 minute but O hour 1 minute O hour 2 minutes and so on.

57. The above time is 24 minutes behind Calcutta time and one hour behind Burma standard time.

RULES FOR SIGNALLING A MESSAGE.

58. *OFFICE CALLS*—Every telegraph office has a code signal which usually consists of two or three letters, thus the call for Howrah is "H H" ; Calcutta "Cal" ; Sealdah "Sda" ; *if either of these stations* desire to send a message *to* Sealdah will say "Sda" and Sealdah will ask the Code of the Station that is calling him, thus "Stn" (Station), and on getting the Code H H or Cal. gives "K" (Go on). The sending station then starts the message commencing *first "Car"(carbonic) followed* by the class code *to enable* the receiving signaller to know that the message is for delivery, and so carbonic paper should be used to take it down in duplicate or simply the class code when the message is *not for delivery* but *for onward transmission.*

ORDER IN WHICH MESSAGES SHOULD BE SIGNALLED.

1. Attack —— . —— . ——
2. Class.
3. Name of the station to
4. Name of the station from preceded by the latter F (From)
5. No. of words preceded by the letter W (Words.)
6. Date, hour, minute, and official instruction, (if any)
7. Sign of separation —— . . . ——
8. Name and Address of the Addressee preceded by the letter T (To).
9. Name of the person From preceded by the letter F (From).
10. Sign of seperation —— . . . ——
11. Text or body of the message.
12. End of message or finished . — . — . followed by the station code of the sending station †

All figures and doubtful words should be repeated by the receiving signaller and acknowledged by the sending signaller to guard against mistakes in receiving them.

† Initials of the sending and receiving signallers are on some Railways substituted for the station codes when finishing a message and acknowledging its receipt.

MISTAKES MADE WHILE SIGNALLING.

59. When the sending signaller finds he has made a letter wrong he should give the error signal . . . . (rub out) and commence with the last word made correctly.

When the receiving signaller finds that he is not getting a word corrèctly he stops the sender by giving the error signal and says "W. A" (Word after) and gives the last word received correctly followed by repeat signal . . — — . . and the sending signaller will commence from that word. After receiving the message, the signaller should be careful to see that he has the right numbers of words as signalled; if they do not agree, he should compare with the sender till the error is found.

The receipt of each message is acknowledged by the code "Rt" (All right) or understood signal . . . — . followed by the station code of the receiving signaller.

60. THE BATTERY.—As the battery is the first essential part of the telegraphic apparatus, the study will properly begin here.

61. It is by the chemical action in the battery that the electric current is first generated. In practical telegraphy this current is made to travel long or short distances through the conducting medium of metalic wires, and by means of the proper instruments, which are herein described, made to give out tangible signals which, being arranged in the form of an alphabet, enables us to read or to speak instantaneously through great distances, for the electric current requires but a small fractions of a second's time to travel many hundreds of miles through the wires, and therefore this art may be rightly termed. "The art of talking by means of signals produced by electricity," from various batteries of which the principal is the Minotto.

THE MINOTTO CELL.

62. The Minotto Cell generally used in India is made up as follows.—At the bottom of an insulated jar (earthen-ware) the following articles are placed :—

1st.—A round or square sheet of copper plate, to which is attached an insulated copper-wire, long enough to reach from the bottom of one cell to the top of the next.

2nd.—Twelve or twenty-four ounces of sulphate of copper, otherwise called bluestone, as the case may require,——12 oz. for a line battery, and 24 oz. for a local battery.

3rd.—A round or square sheet of blotting paper or coarse cloth.

4th.—Sand or Saw-dust called diaphragm.

5th.—Another sheet of blotting paper or coarse cloth.

6th.—Zinc disc with a brass binding screw.

7th.—Water enough to cover the zinc disc (*vide* plate 1). To short circuit a cell, join the insulated copper-wire which is attached to the copper plate to the zinc disc of the same cell ; this being done brings the cell into working order, as cells, when first prepared, offer a very high resistance.

63. To form a battery join the copper pole of one cell to the zinc pole of the next cell and so on up to the number of cells required. (*vide* plate 2.)

64. When circuit is completed current flows from the copper pole of the cell or battery as the case may be.

EXPLANATION OF THE TWO KINDS OF TELEGRAPH CIRCUIT.

65. We have explained the circuit (page 3, para 2) to be the whole path along which the electricity is supposed to flow, and we may consider the two cases in which the electric currents are flowing and in which they are not. If we erect a wire between Beliaghatta and Sealdah stations, the end at each place being connected with the earth, then the whole path from Beliaghatta to Sealdah along the wire and again from Sealdah to Beliaghatta through the ground is the circuit, this circuit may either have a current flowing through it or it may be free from all current. In the latter case the circuit is said to be open, and in the former case to be closed.

THE LIGHTNING DISCHARGER.

66. This instrument is used to prevent damage to the receiving instruments—it consists of two brass plates placed one over the other,

the upper surface of the lower plate and the lower surface of the upper plate are grooved at right angles to each other, the plates are insulated (that is, kept apart) by pieces of ebonite, each plate has two binding screws, the screws marked L is in connection with the upper plate and E lower, one screw of upper plate is joined to the line wire both in open and close circuit, the other screw of the upper plate is joined to the centre screw of the key in open and also in closed circuit. (*vide* plate 3.)

67. Only one of the screws of the lower plate is joined to the earth, the other is left quiet for testing.

The reason why the inner surfaces of the plates are grooved is that lightning having a tendency to concentrate on points to discharge itself, the object of the grooves at being placed at right angles to one another is to form cones and collect the powerful charge of the atmospheric lightning from the upper plate and as there is very little resistance offered to its passage by the plates it takes the shortest route to earth by the lower plate instead of by the receiving instrument coils and fuse them. The faults peculiar to lightning discharger are contacts either between the upper and lower plates or between the upper parts themselves.

68. Both are usually the result of dust collecting between the plates or on the surfaces of the ebonite washers which separate them, causing either loss of current by leakage to the ground, or forming a partial contact between two or more lines, and the result is that the currents sent through one affect the receiving instrument of the others.

69. The Lightning Discharger should be dusted with the instrument brush every day, and its cover should always be kept on.

THE KEY.

70. A key is used for signalling by making and breaking or breaking and making a circuit quickly. It consists of a brass lever pivoted at its centre and by means of a spring it is made to rest against the stop

at the back, which is called the back contact; the stop against which the lever hits when the knob is pressed is called the front contact.

71. IN OPEN CIRCUIT, the back contact screw is connected to the L screw of the sounder or the lelay, the centre screw to the L screw of the lightning discharger, and the front contact screw to the copper pole, the zinc pole of course, being put to earth, at terminal stations, thus whenever the key is pressed it is brought in contact with the battery and the current flows to line. The moment the key is raised the contact is broken and the current at the same moment ceases. The duration of the current thus evidently depends upon the duration of this contact; hence to send dots and dashes by the key it is only necessary to move the lever up and down. (*vide* plate 4.)

72. IN CLOSED CIRCUIT, the front contact screw is connected to nothing, the centre screw to L screw of the lightning discharger and the back contact screw to L screw of the sounder or relay through which the copper pole of the battery is in connection with the back contact, the zinc pole being put to earth the result of which is that the current is continually flowing through the back contact to line, thus whenever the key is pressed the contact at the back is broken, and the current at the same moment ceases, but directly the knob is left the back contact is closed up and the current at the same time again flows thus dots and dashes are signalled by the absence of current. (*vide* plate 5.)

73. The key is provided with screws at the front and back of the lever with jam nuts for the purpose of regulating its "play" to suit the hand of the signaller. A little practice will enable the student to judge best for himself as to how this should be set.

THE SOUNDER.

74. The Morse sounder is the instrument usually put up for receiving messages by sound,hence the name sounder,which is of three patterns, namely: Dubern's Sounder, Douglas Sounder and Siemens' Sounder

used with Siemens' relay. Any of these sounders are constructed as follows:—Two bars of soft iron are joined together by means of a short flat bar of iron similarly soft. The round bars are called "*Cores*", the flat connecting bar at the back is called the 'middle bar" or "heel piece." The movable round piece of iron in front which is to be attracted by magnetism to the cores or withdrawn by the spiral spring when no magnetism excites the cores is called the "*Armature.*" The two stops, one in front or nearest the coil is called the "*Working-stop screw*" and the other at the back furthest from the coil is called the "*Rest-stop screw*"—both these screws are insulated (that is, kept apart) from the brass plate by pieces of ebonite placed underneath the pillars.

75. A silk or cotton-covered wire is wound in continuous turns about the cores until the diameter of an inch and-a-half is attained, and each core or spool of the magnet, as it is called, contains a great number of turns of the wire round it. Now, if a current of electricity be sent through this wire, it will, by its passing through the numerous turns, cause the iron cores within to become magnetic and to possess the power of attracting with considerable force any piece of iron near to their ends. The cores being made of soft iron will lose their magnetism and cease to exert any attractive power the moment the current ceases to flow (*Vide* para 19). The actual power of the attractive force thus exerted is directly dependent upon the power of the battery which supplies the current, or, more properly speaking, upon the power of the current itself. Strong currents will cause the electro-magnet, as it is called, to attract with the power of several pounds.

THE DUBERN SOUNDER.

76. Its internal connections are :—

Screw L is joined to one end of the coils.
,, J ,, to both the coils through the connecting rod.
,, E ,, to the other end of the coils.
,, 2 ,, to working-stop screw through the front pillar.
,, T ,, to the armature.
,, 1 ,, to rest-stop screw through the back pillar.

N.B.—Remember both pillars are insulated from base brass plate by pieces of ebonite.

77. The external connections are—(In open circuit) :—

Screw L is joined to back contact screw of the key.

" J is joined to either to earth or back contact screw of the key as an alternative arrangement (when one of the coils is fused or damaged.)

" 2 is joined to one flap of the bell switch, and

" T " to the copper pole of the battery when a bell is used. (Vide plate 6.)

78. The external connections are—(In closed circuit) :—

Screw L is joined to back contact of the key.

" J is joined to either to copper pole or back contact of the key as an alternative arrangement (when one of the coils is fused or damaged.)

" E is joined to copper or zinc pole of the battery, the other pole being put to earth. (Vide plate 7.)

79. The Translation connections are—

Screw 1 is joined to the screw L of the opposite side sounder.

" T is joined to the screw T of the opposite side switch.

" 2 is joined to the copper pole of the opposite line battery (Vide plate 8.)

THE DOUGLAS SOUNDER.

80. It has also six terminal screws marked 1, C, L, Z, 2 and T.

The internal connections are :—

Screw 1 is joined to front pillar or working stop.

" C " to lower front contact of the key.

" L " to one end of the coils through the lever and upper contact of the key.

" Z " to the other end of the coils.

" 2 " to back pillar or rest stop.

" T " to the beam through the brass plate and supports.

81. The external connections are—(In open circuit) :—

Screw C is joined to the copper pole of the line battery, zinc being put to earth.
- ,, L is joined to the line.
- ,, Z is joined to earth.
- ,, 1 is joined to one flap of the bell switch.
- ,, T is joined to the copper pole when a bell is used.

The external connections are (In closed circuit) :—

Screw L is joined to line.
- ,, Z is joined to Copper or Zinc pole of the battery, the other pole being put to earth.

82. The Translation connections are :—

Screw 2 is joined to the screw L of the opposite side sounder.
- ,, T is joined to the screw T of the opposite switch flap.
- ,, 1 is joined to the copper pole of the opposite line battery.

THE SIEMENS' SOUNDER.

83. This instrument has five terminal screws marked C, A, 1, T, and 2.

The internal connections are :—

Screw C is joined to one end of the coils.
- ,, A ,, to the other end of the coils.
- ,, 1 ,, to the front contact or lower pillar.
- ,, 2 ,, to the back contact or upper pillar.

N.B.—As this intrument is always used with relay its external connections will be shown after the description to the Siemens' Relay.

THE RELAY.

84. The relay is, in fact nothing more or less than a more delicate form of the electro-magnet and lever employed in the sounder previously described. Its cores are wound with a finer and longer wire, so that it will move with the weakest currents. However long a line may be, and however badly it may be insulated, if any currents at all

can get through, so long can relays be constructed to move with those currents.

85. There are many different forms of relay, but the one used with the Siemens' Relay is called a *polarised relay*, because its armature and core are maintained in a magnetised condition by an L shaped permanent magnet.—(See para 22.) A polarised relay is more sensitive than a non-polarised one.

THE SEIMENS' RELAY.

This instrument has five terminal screws marked L, E, A, Z, and B.

86. The internal connections are :—

Screw L is joined to one end of the coils.
,, E ,, to the other end of the coils.
,, A ,, to the working stop.
,, Z ,, to the armature, or tongue and
,, B ,, to the rest-stop.

N.B.—The shoes and the armature or tongue as it is called being in connection with the permanent magnet they, by action of induction, become induced magnet, and the former attracts the latter, but whichever shoe is nearer to the tongue draws it with greater force than the other ; consequently when the line current is weak the milled headed screw or micro-meter screw should be screwed in but when the tongue sticks to the working stop screw it should be withdrawn slowly until the tongue works freely.

87. The external connections are—(In open circuit)—

Screw L is joined to the rest-stop screw of the key.
,, E is joined to earth.
,, A is joined to A of the sounder, and
,, Z is joined to zinc pole of the local battery, the copper pole of which goes to Screw C of its sounder. *(Vide plates* 9 and 10.*)*

88. The external connections are—(In closed circuit)—

Screw L is joined to the rest-stop screw of the key.
,, E is joined to line.
Z is joined to the zinc pole of the local battery and

Screw B to A of the sounder, and second screw of the key is joined to the copper pole of the line battery, zinc being put to earth.

N. B.—Care should be taken that the copper current enters from the Screw L of the relay always. (2) It should also be remembered that the beat is observed only on the relay, and not on the sounder, and the sounder consequently works as if it were an open circuit. (3) If a beat is observed on the sounder it indicates that the circuit is broken, or in other words there is a disconnection somewhere.

THE MAGNETIC NEEDLE INDICATOR.

89. The MAGNETIC NEEDLE INDICATOR is placed on sounders and relays to indicate the state of communication. In the open circuit, the incoming current will deflect the needle if the line is perfect. If the line is broken and insulated, or broken and making earth, there will be no deflection.

90. In closed circuit if the line is perfect and circuit complete there being a permanent current on, the indicator while signalling or receiving will deflect with the sent signals. If the line is broken and insulated there will be no deflection, but if the line is broken and making earth the indicator will deflect with the sent signals only.

91. If at any time the sounder or the relay gets locked, through the influence of terrestrial magnetism or some other cause, the needle deflecting with the received signals will give index to the fault in the sounder or the relay if a relay is used.

92. The needle indicator is a very sensitive and useful little instrument in its way to enable a signaller to discover certain faults in his instrument.

THE ELECTRIC BELLS.

93. To call the attention of the signaller that a message on the Train Wire is waiting an electric bell is used with the receiving

THE SHORT CIRCUITING OR TREMBLING BELL.

94. It has two terminal screws which are connected to the two ends of the coils of the electro-magnet as described below.

One end of the coils is connected to one of the terminal screw through the *Armature* which carries a hammer and a flat spring facing a screw called the *adjusting* screw.

And the other end of the coils is connected to the other terminal screw through the adjusting screw.

The external connection are (in open circuit) :—

One terminal screw is joined to one flap of a S. C. switch and the other flap is joined to screw 2 of a Dubern or screw 1 of a Douglas sounder.

And the other screw of the bell is joined to earth *(Vdie plate* 11.)

95. Action :—When the bell armature is attracted the hammer hits the bell, and the flat spring comes in contact with the adjusting screw. The current in this position, no more flows through the coils of the electro-magnet, it being short circuited, and takes its course through the flat spring of the armature and the adjusting screw but, as soon as this occurs the armature flies back by the action of the flat spring, and the current again flows through the coils, the armature is again attracted and so on, which causes the bell to give out a trembling sound as long as the current lasts.

N.B. In adjusting this pattern of bell care should be taken that the spring does not touch the adjusting screw but that a space of about, not more than the thickness of a letter paper, be left always between the spring and the adjusting Screw.

THE CHATTERING BELL

96. This kind of bell is also sometime called a *broken circuit* bell because its chattering or trembling sound is produced by the breaking of the circuit at its spring and the adjusting screw.

Its external connections are (in open circuit) :—

One flap of the switch is joined to screw 2 of sounder and the other flap of the switch is joined to earth (Vide plate 12.)

N.B. 1. To adjust this kind of bell particular case should be taken to see that the spring which is attached to the armature rests against and makes contact with the adjusting screw.

2 To put the bell coils in circuit the plug must be taken out of the switch and when the bell is not required to ring the plug should be put in.

THE BELL LOCAL CIRCUIT AND THE COURSE OF THE CURRENT.

97. Under the action of the receiving current the armature of the sounder is brought in contact with the front pillar; this generates the local current which takes its course from the copper pole of the line battery, the connecting wires, front contact of the key, the screw T and the armature of the sounder, front pillar, working-stop screw, one terminal screw of the bell, the bell coils the switch and back to the zinc pole of the battery through the other terminal of the bell.

The local current can be produced by pressing the armature against the working stop screw by hand, the bell rings when the current passes through the bell coils.

THE SWITCHES.

98. A SWITCH is a kind of flap which opens and shuts by means of a metal pin called a *plug*. When the plug is in the hole it makes way for the current, and when the plug is out it shuts against the current.

99. A short-circuiting switch which consists of two flaps is used with a bell ; one of its flaps is joined to the bell terminal screw and the other to front pillar of the sounder. It is also used in closed circuit for joining two sections of a wire ; one of the flaps are joined to the poles of the two batteries and the other flap to earth.

100. For open circuit translation working S. T. D. switch consisting of four flaps are generally used in Railway Offices.

PRACTICAL INSTRUCTIONS.

NAMES OF RAILWAY WIRE.

101. On lines where there are three wires, the station to station wire is the "Train Wire."

102. The wire joining every second or third station is the "Through Wire"

103. The wire which only connects important stations is the "Main" or "Intermediate Wire ."

OPEN CIRCUIT.

104. Q. How will you connect a discharger, sounder and key to enable you to work in "Open Circuit?"

A. (1) By leading the line wire from the front screw of the upper plate of the discharger to the second screw of the key.

(2) A wire from the third screw of the key to screw L of the sounder.

(3) A wire from the copper pole of the battery to the first screw of the key.

(4) A wire from the zinc and earth of the battery to screw E of the sounder. *(Vide plate* 13.*)*

(5) At all intermediate stations, if it is not a train wire don't use earth to screw E of the sounder, but connect there the line wire which comes in from the left hand side along with the zinc pole of the battery. *(Vide plate* 10.*)*

CLOSED CIRCUIT.

105. Q. How will you connect a discharger, sounder and key to enable you to work in "Closed Circuit?"

A. (1) By leading the line wire from the front screw of the upper plate of the discharger to the second screw of the key.

(2) A wire from the third screw of the key to screw L of the sounder.

(3) A wire from the zinc to earth and copper of the battery to screw E of the sounder at one end and copper to earth and zinc to screw E of the sounder at the other end. *(Vide plate* 14.*)*

GENERAL RULES.

TO BE OBSERVED BY SIGNALLERS IN THE SIGNAL ROOM.

106. Prompt attention is to be given to all telegarph work. A station when called must answer at once, but if the signaller be be engaged in clearing messages of superior class than the one offered by the station that has called him, he should give "wait working." But as soon as he is disengaged he must call that station to whom he gave "wait" and clear him. (For working signals see para 51 pages 15—17.)

107. Except in the case of a Railway "Danger service" message (D D D) or "Clear the line" Government message (O O O) a signaller on the Main or Through wire must on no account interrupt when two other stations are working.

108. A signaller at an intermediate station on the Main or Through wire must not (except in the event of interruption) put the instrument to Earth with a view to cutting out other stations from the use of the circuit.

109. When two or more sections on the Main or Through wire are provided with a central controlling station with "Translation" or other switch arrangments for direct communication, the signaller on duty at the Controlling station must watch, and be careful that the sounders are adjusted when out ; and that not to allow both sections to remain joined, when two stations on the same side are working together.

110. All telegraph instruments must be kept quite clean, and free from dirt and dust ; the contacts of the key, sounder and relays must be cleaned every morning ; the lightning dischargers dusted regularly ; and the covers of the instruments always kept on. The batteries also are to be cleaned of the froth and dirt, and replenished with fresh water in the interval of the batteryman's visits.

111. All wires attached to the terminals should fit well and the nuts screwed down tightly, but care must be taken, that the run of the hooks of the wire is so directed, that the turning down of the screw tends to close the hook and not to open it ; that is to say the ends of the wire should be bent from left to right to make the hook and not from right to left.

ADJUSTMENTS.

112. AMERICAN CURVED KEY.—Adjust the key by the following process :—

I. Unscrew the jam-nuts of the back contact and the worm-spring screws.

II. Uncrew the worm-spring screw and back-contact screw.

III. Press the knob and screw down the back-contact screw until a space of about one thick brown paper (for an open circuit) or two brown paper (for a closed circuit) is left between the screw and the contact plate and then tighten its jam-nut.

IV. Send attacks and with the left hand gradually screw down the worm spring screw, until the spring is hard enough to allow the wrist to move up and down easily, but should make a firm contact at the back contact plate when the key is in its normal or rest position.

113. DOUGLAS KEY.—This kind of key is adjusted by the following process :—

I. Open the jam-nut and unscrew the upper-contact screw.

II. Send attack and with the left hand adjust the upper-contact screw by screwing it down, until the play of the key is large enough as descirbed in the case of the curved key ; but care should be taken that a firm upward contact is obtained at the adjusting screw when the lever is at rest.

III. Put the jam-nut firmly on to the adjusting screw.

114. DURBERN SOUNDER.—Adjust the sounder by the following process :—

I. *Loosen the jam-nuts and unscrew the working* and rest stop-screws and also the spiral spring until the armature falls on the electro-magnent.

II. Hold the working stop-screw with the right hand, and rest stop-screw with the left hand, and gently screw in the both, equally *until the armature is brought in the middle of the two poles of the* electro-magnet.

III. When thus adjusted clamp up the jam-nut of the rest stop-serew and open out the working stop-screw until a piece of brown paper should pass between them (that is, between the screw and *the armature*) *and then* clamp up the jam-nut.

IV. Put your right hand forefinger to the armature and find out the strength of the attraction, after which tighten or loosen slowly as required, the spirial spring until clear readable signals are heard ; but should the armature stick when fast attacks are given, screw in the working stop-screw and unscrew the rest-stop-screw slowly, until the sticking sound is heard no more.

N. B.—For Closed Circuit the space is made between the rest stop-screw and the armature which should be double that of an Open Circuit, say, about the thickness of doubled brown paper.

115. DOUGLAS AND SEIMENS' SOUNDERS.—Are adjusted thus :—

I. Loosen the jam-nuts of the working and rest stops and screw down the lower stops until the armature falls on the electro-magnet.

II. Raise the working-stop-screw by unscrewing it until a thin letter paper can pass between it and the poles of the electro-magnet with a friction.

III. Hold the working stop with the left hand and screw down tightly its jam-nut.

IV. Raise up the rest-stop screw until a space of one thick brown paper (in an open circuit) or two brown paper (in a closed circuit) is left between it and the beam.

V. Hold the rest-stop with the left hand and put the jam-nut on and ask the distant station to send attack.

VI. After which tighten or loosen the spiral spring when the attack is given (according as the received current is strong or weak) until clear and readable signals are heard.

116. SEIMENS' RELAY.—This instrument is adjusted thus :—

I. Set the tongue in the middle between the working and rest stops by screwing them in equally till they jam the tongue.

II. Set the two shoes about one tenth of an inch away from the tongue.

III. Unscrew the working stop until a space of about one thick foolscape-paper is left between the tongue and the stop.

IV. Ask the distant station to send attack ; the tongue should strike against the working stop and reproduce the attack on the sounder.

V. If the tongue sticks to the working-stop draw out the right hand shoe very gradually away from the tongue, by unscrewing the milled-headed or micrometer screw as it is called gently until the sounder works all-right.

VI. On the other hand if the tongue fails to strike against the working stop (this is owing to the line current being weak) the micrometer screw should be gradually and very gently screwed in until the tongue strikes and the sounder works all-right.

117. S. C. BELL.—Adust the bell thus :—

I. Whilst the current passes the bell coils, loosen the bell nut to enable the bell being turned round:

II. Unclamp and unscrew the adjusting screw well back, and turn the bell round until the hammer rests slightly on the bell, and the armature lies evenly above the poles of the electro-magnet.

III. When thus thrown out of adjustment commence to screw in very slowly the adjusting screw, which will make a contact with the clock spring of the armature, and gradually give out quick successive beats on the bell.

IV. Then turn the bell round very slowly until clear trembling sound is heard.

V. Screw tight the bell nut and clamp up the jam-nut ; but care should be taken that the adjusting screw is not driven in, and the bell coils short circuted, when you are screwing in the jam-nut. (See para 95.)

TESTING INSTRUCTION.

118. Q. What is the first thing to be done when there is an interruption ?

A. Examine the wire interrupted from the terminal post to the office, the leading-in wire ; wires attached to the terminals of instrument, and, lastly, see that all the instrument screws are clean and properly screwed on the wire hooks, after which test the battery, sounder and lightning-discharger. (See para 110.)

119. Q. How will you test to know that the sounder and battery at a terminal station working in open circuit are in order ?

A. Disconnect the line wire from the middle screw of the key, and then join with a piece of wire the middle and first screw of the key, there should then be a strong beat on the sounder showing that the battery, key and sounder are all-right. If there be no beat, join first screw of the key and L screw of the sounder, if there is now a beat on then the key is faulty, or the wire connecting the third screw of the key and L of the sounder is broken.

120. Q. How will you know that the instrument and battery at an intermediate station working in an Open Circuit are in order ?

A. Disconnect the up and down line wires at the lightning discharger, and with a piece of wire connect the two L screws together and press the key, if one instrument works the other, then the battery and instrument, are all-right ; if not, change the up and down instrument, and so find out if the sounder is defective.

121. Q. How will you change up and down instruments to find out the faulty sounder ?

A. By crossing the line wires at the furthest end of the lightning discharger ; or, in other words, putting the up line in place of down line and down line in place of up line.

122. Q. How will you test to find out that the lighting-discharger at a terminal station in an Open Circuit is in order ?

A. By disconnecting the line wire from the lighting-discharger at the side furthest from the instrument, and the earth wire from E screw of the sounder, then with a piece of wire connect E screw of the sounder and first screw of the key, there should be no beat, but, if otherwise, it shows that the upper and lower plates are touching one another, and the current passes off to earth and returns to zinc pole of the battery, hence the beat.

123. Q. How will you know that there is something wrong in a Closed Circuit ?

A. By the Beam or the Armature being off from the front pillar screw.

124. Q. How is the testing done to know that the instrument and battery are all-right at a terminal station working in a Closed Circuit ?

A. I will touch with a piece of wire the binding screw marked L, or the line with the earth-wire, when, if the battery and instrument are all-right, there will be a strong beat on the sounder.

125. Q. How will you test to find out at an intermidiate station in Closed Circnit the side which is faulty.

A. I will put on earth-wire first at the up-line binding screw ; then at the down-line binding screw ; if the circuit be only broken on one side, I will get the permanent beat again, on putting the Earth wire on the faulty side and be able to work on the side which is not faulty. But only the station nearest the fault should put on "Earth" and report insterruption

126. Q. How will you localize fault and carry on work at an intermidiate station on an open Through Wire ?

A. I will put on Earth first at the up line by connecting earth wire from the discharger to E screw of sounder or relay, and then on the down line by crossing the lines at the furthest end of the discharger and call the stations ; if the circuit be only broken on one side I will get the station and be able to work on the side which is not faulty.

127. Q. What case is there in Closed Circuit in which there is nothing to show that the line is broken or faulty ?

A. When line makes "earth" by being in contact with the ground. (2) Upper and lower plates of a lightning discharge touching one another. (3) Or the line wire broken and touching one of the telegraph posts, thus causing the circuit to be completed which keeps the beat on : and the result is that there is nothing to show that the line is faulty except that you wont get station beyond the fault ; and in this case the station beyond the fault should be reported as interrupted

128. Q. By what test will you find out that the discharger at a terminal station in a Closed Circuit is defective ?

A. If after disconnecting the line wire at the discharger you find that there is a beat on, then the upper and lower plates of the discharger are touching one another ; and to enable the work being done, they should be separated or the discharger changed.

129. Q. By what test will you find out that the discharger is all-right at an intermediate station of a Closed Circuit ?

A. If after throwing off the lines at the discharger, first the up line, then the down line, and on whichever side a beat is noticed, then that side upper and lower plates are in contact with each other ; immediate steps therefore should be taken to raise the upper plate, and if it is damaged ask the Inspg. Tele. Master to replace the discharger by a new one.

130. Suppose your instrument is faulty, how will you ascertain that the battery is all-right without the help of a battery detector or a Tangent galvanometer ?

A. I will take a white glass tumbler filled with clean water and immerse in it the zinc and copper poles without touching each other ; if the battery is all-right bubbles will be seen at the end of the zinc pole and a heavy substance of smoky appearance at the end of the copper pole in the water.

131. Q. Suppose your battery is faulty, how will you arrive at the faulty cells with the help of a sounder ?

A. I will divide the number of cells into two rows and will be able to work with the one which is not faulty. To find out the faulty cells I will repeat the same exp iment with the faulty row, in each case, until I reach the faulty cell or cells.

132. Q. What steps must be taken by the Signaller-in-charge before reporting interruption ?

A. He must see that the leading-in wires are not broken or in contact ; open, loose or dirty connections ; proper adjustment of the instrument ; dirt between upper and lower plates of the lighting-discharger ; defects in the battery and instrument ; and lastly, see that line wire is not broken, or in contact up to the distant signal ; and report the nature of the fault to the A. S., I. T. M., L. M. and D. T. S. of the district by an X T telegram in Code language,

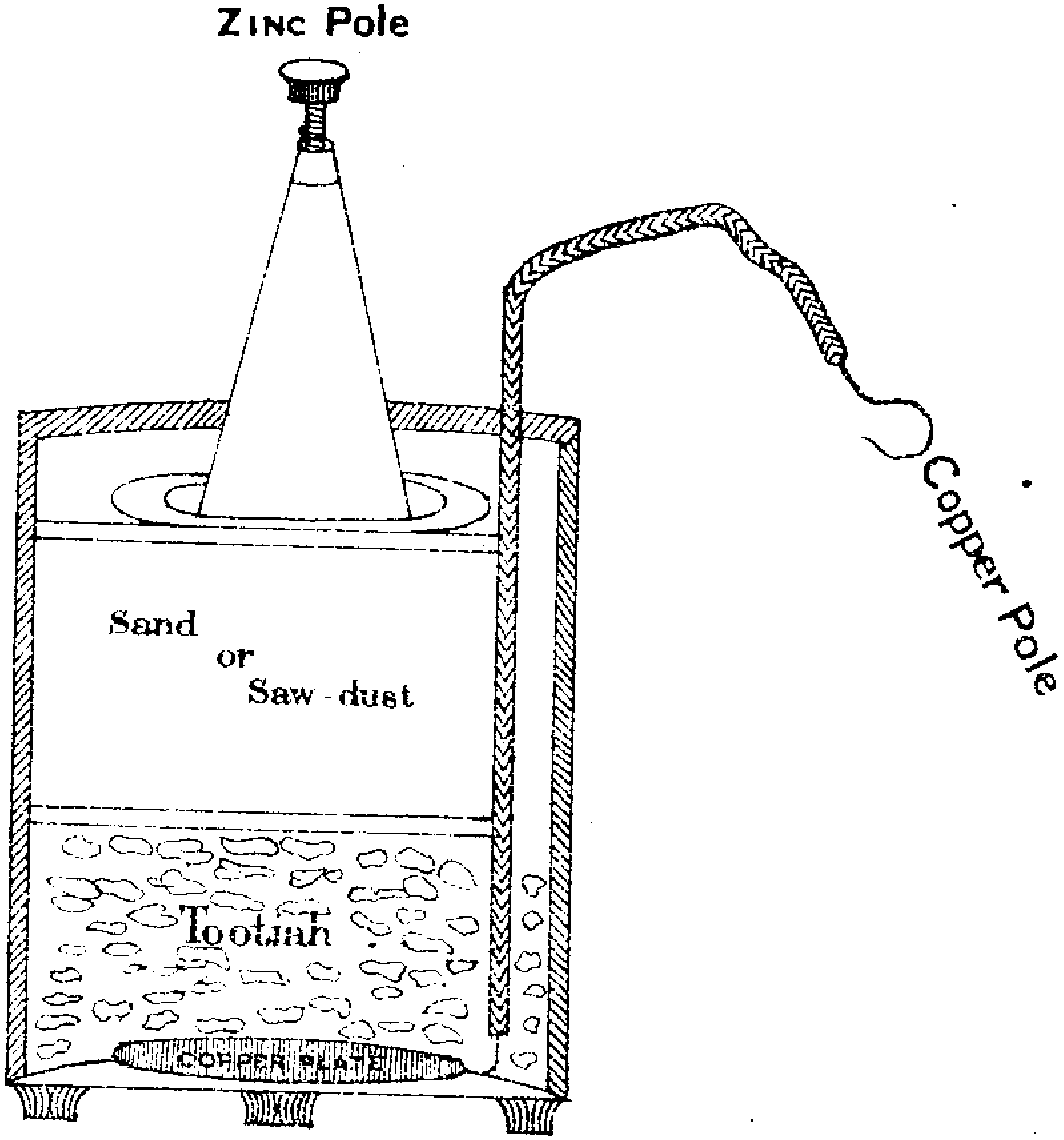
133. Q. Suppose lines are in contact, how would you know it ?

A. By the stray signals of one line making its way into another, and causing a confusion on the instruments.

134. Q. When communication is restored, what should be done ?

A. The fact should be reported as before to A. S., I. T. M., L. M., and D. T. S., of the district by an X T message in Code language, and on arrival of the lineman the Interruption Report form in duplicate should be made out and sent by post to the Asstt Supdt. Teles.

PLATE No 1



Minotto Cell. *See para 62*

PLATE. No 2

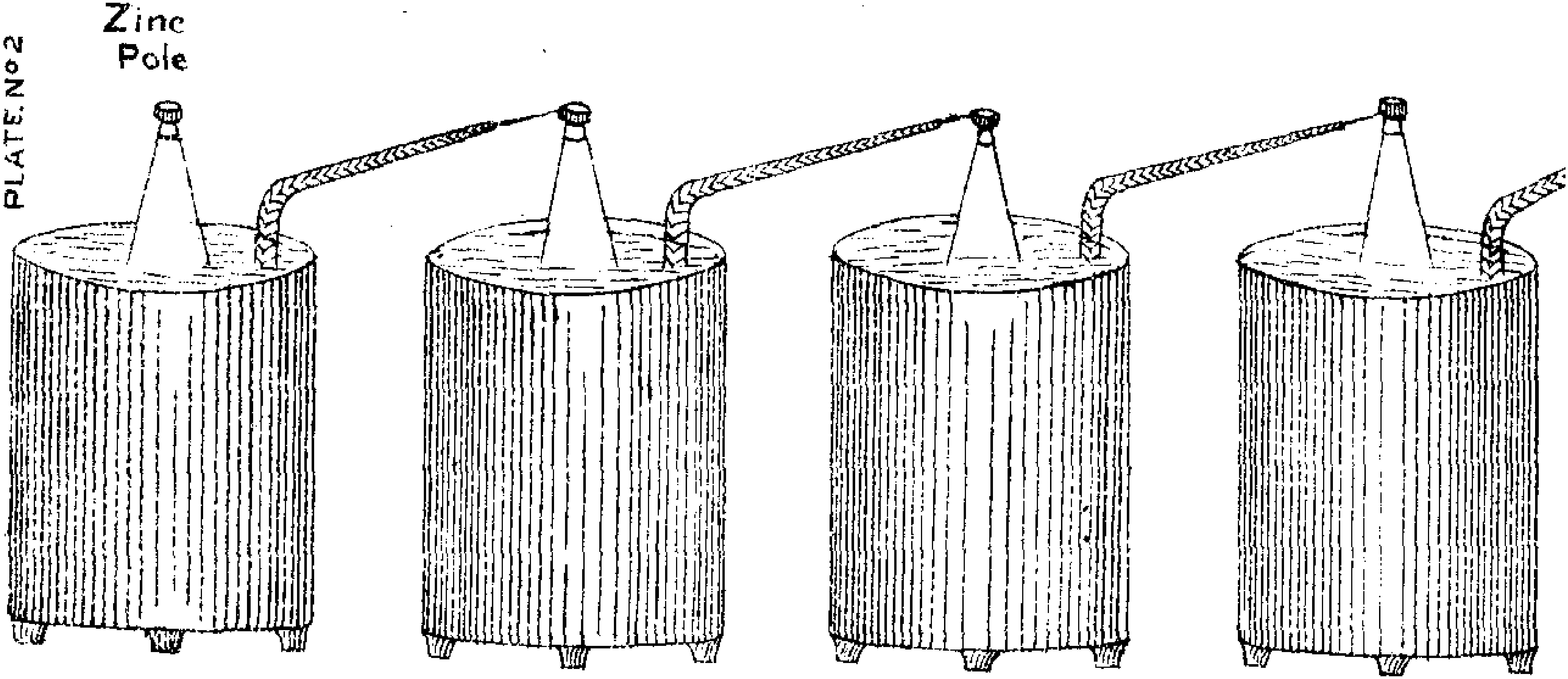


Diagram showing how cells to be joined to form a Battery. See para 64.

Plate No3

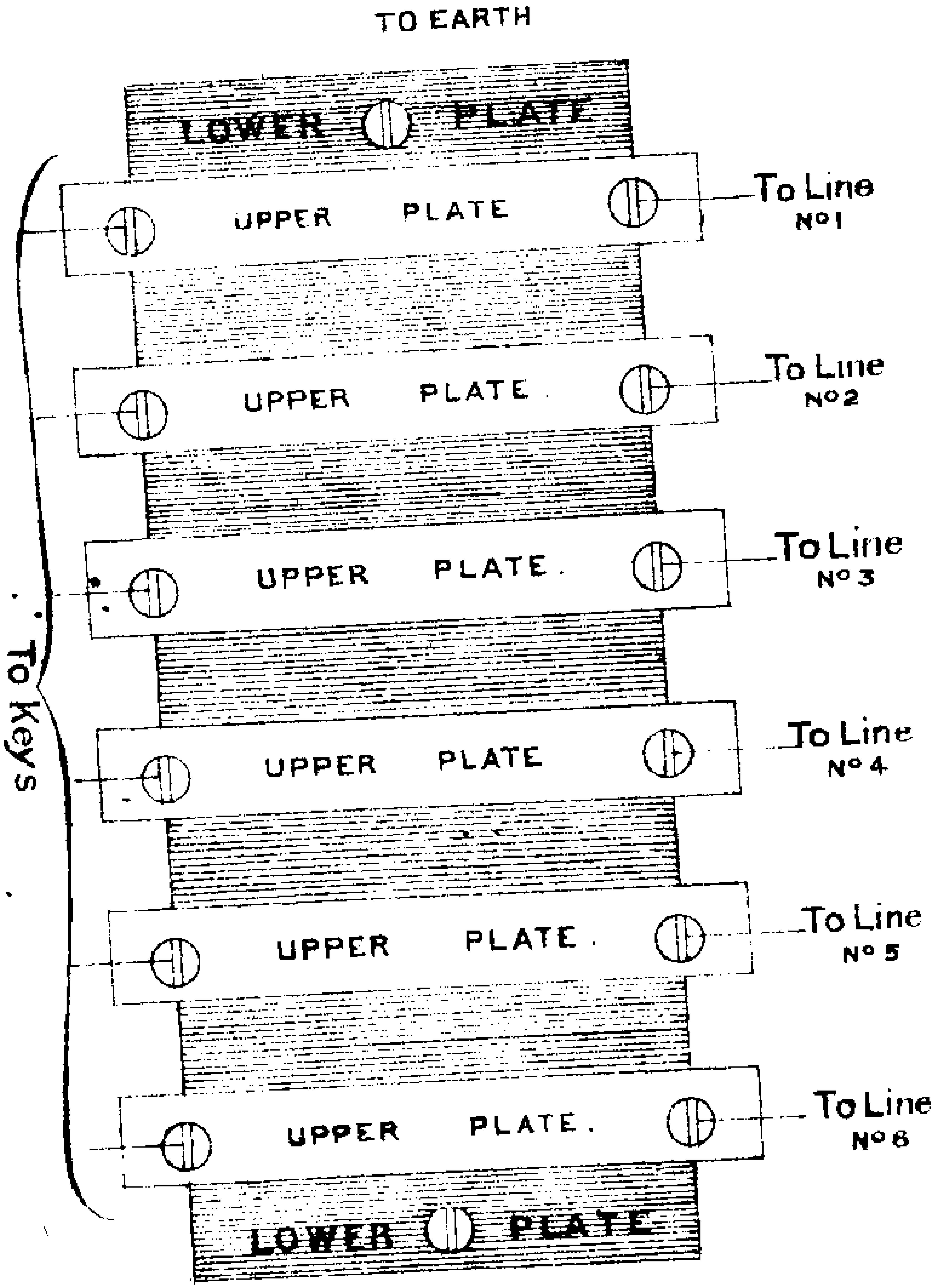
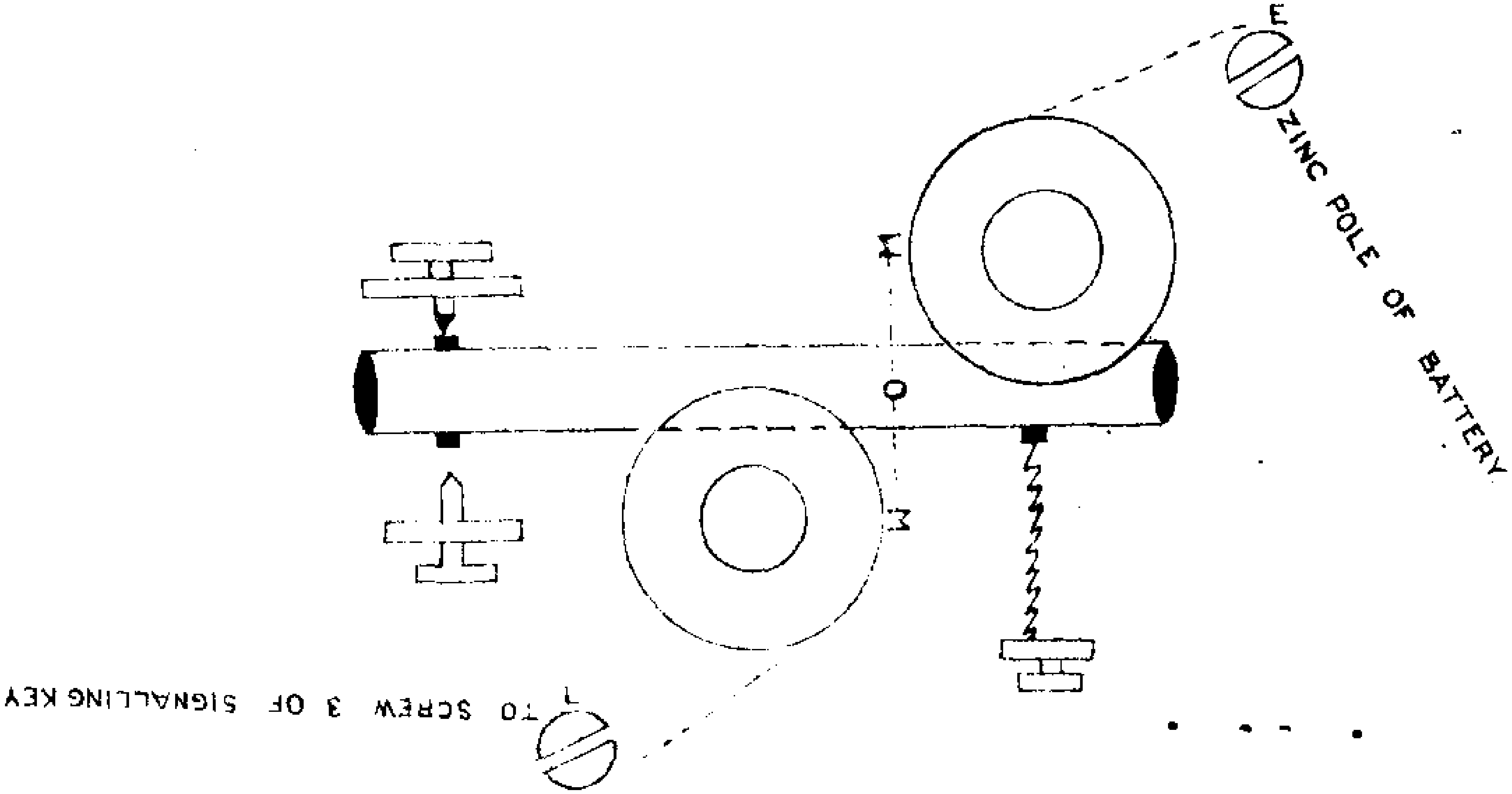
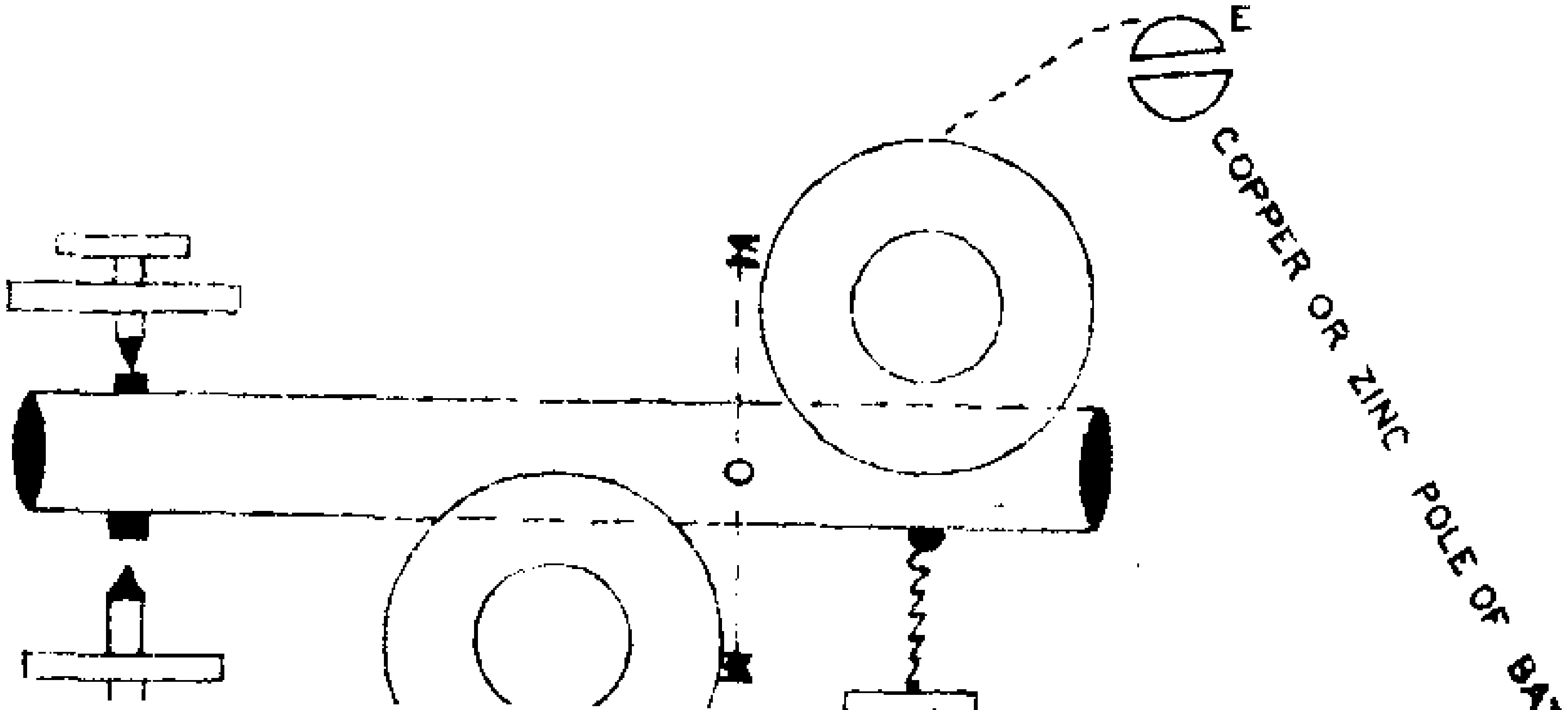

TO EARTH
LOWER PLATE
UPPER PLATE
To Line No 1
UPPER PLATE
To Line No 2
UPPER PLATE
To Line No 3
UPPER PLATE
To Line No 4
UPPER PLATE
To Line No 5
UPPER PLATE
To Line No 6
To Keys
LOWER PLATE

Plate No 6



Dubern Sounder in open Circuit

Plate No 7



TRANSLATION CONNECTIONS BETWEEN 2 WIRES

PLATE No 8

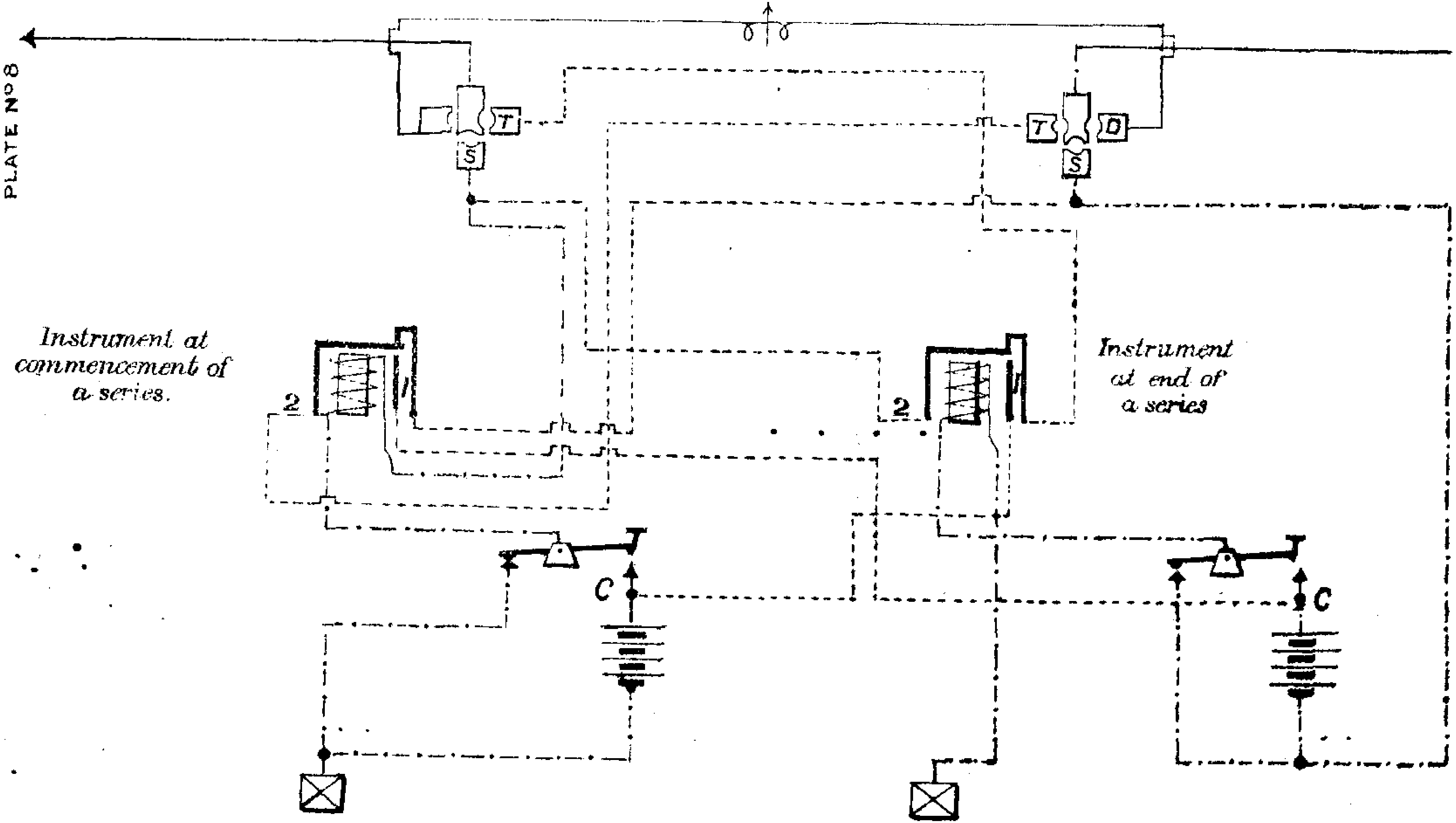
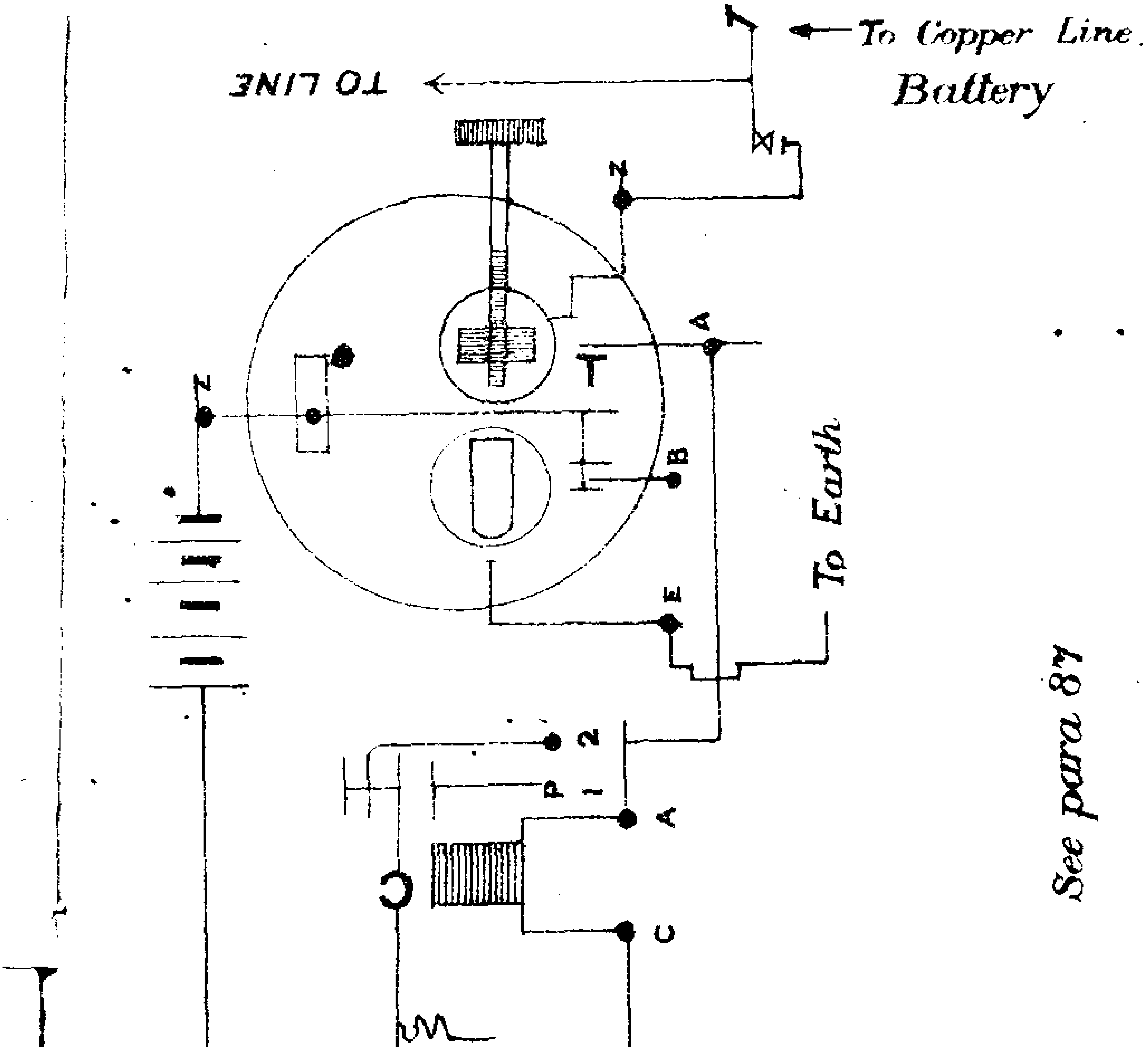

T
S
T
D
S
Instrument at commencement of a series.
2
1
Instrument at end of a series
2
1
C
C

PLATE No 9

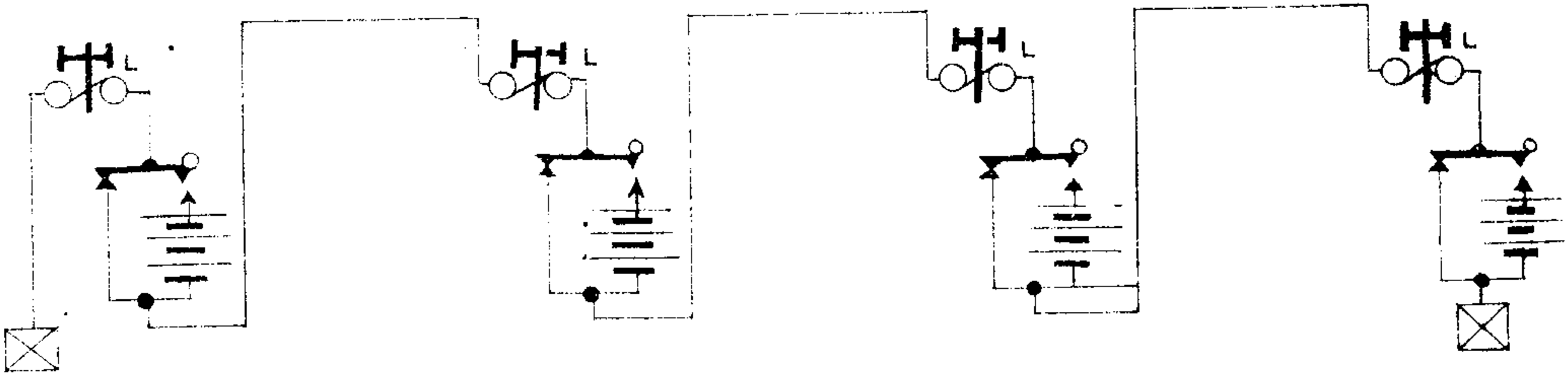


See para 87

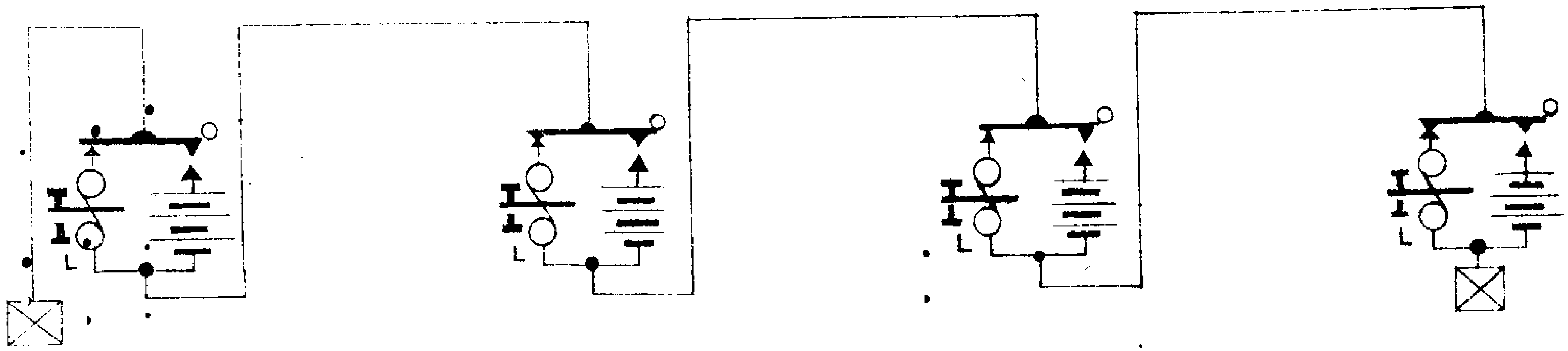
Plate No 10

OPEN CIRCUIT THROUGH WORKING

I

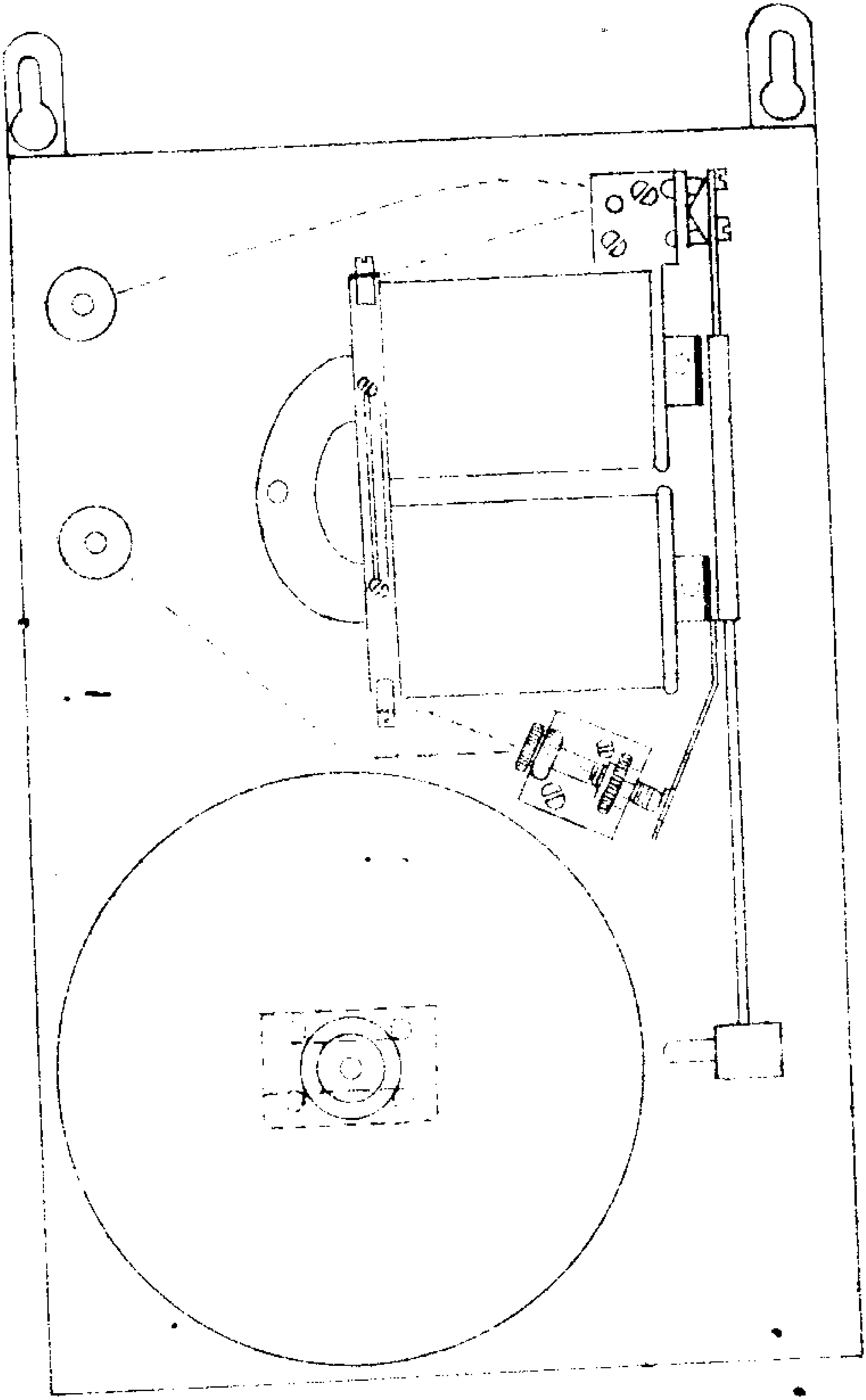


II



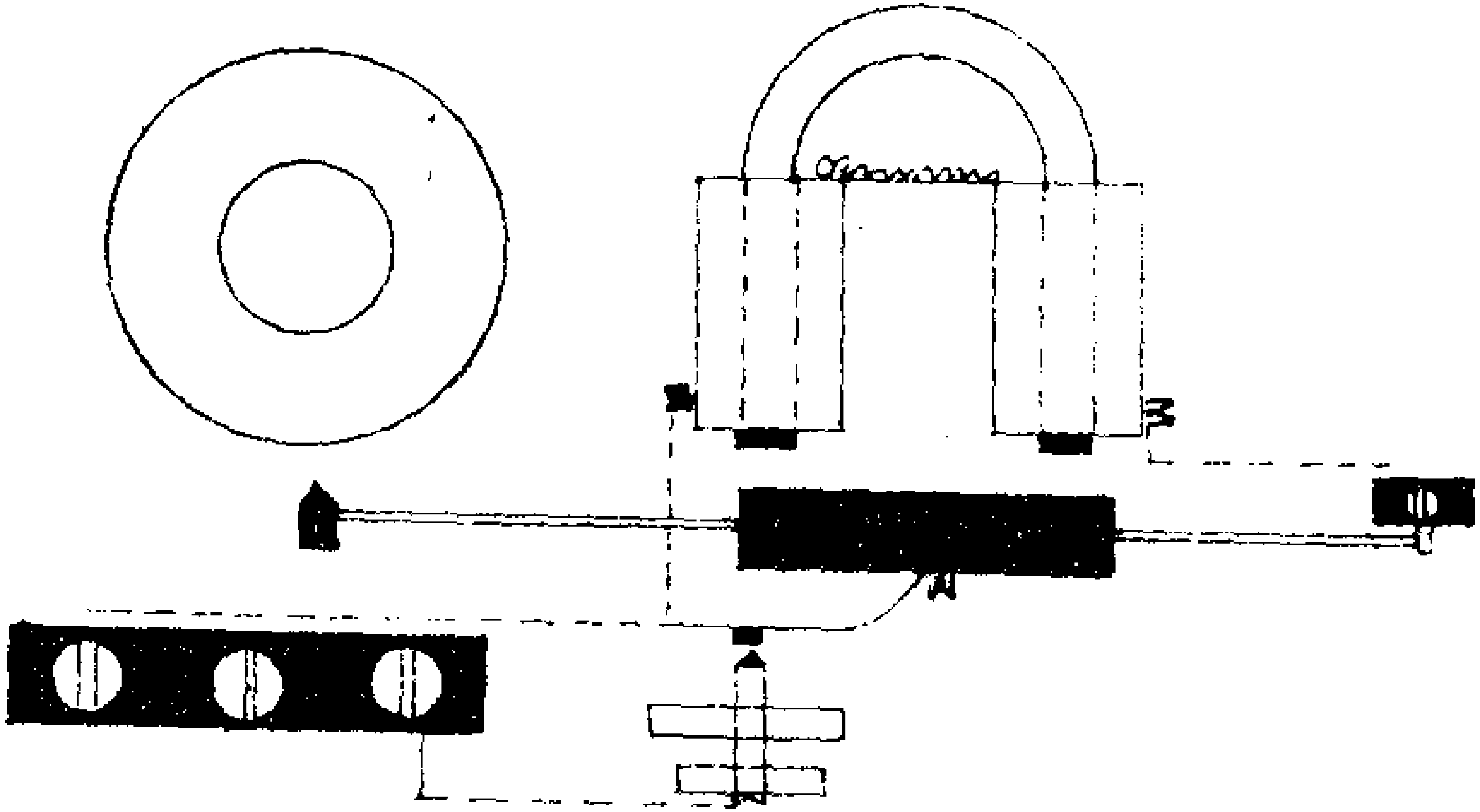
NOTE. Either of these methods can be used with Relays by taking care that the L connection of the Relays is placed in the position marked by the letter L in the above sketch

Plate No II



TREMBLING BELL

Plate No 12

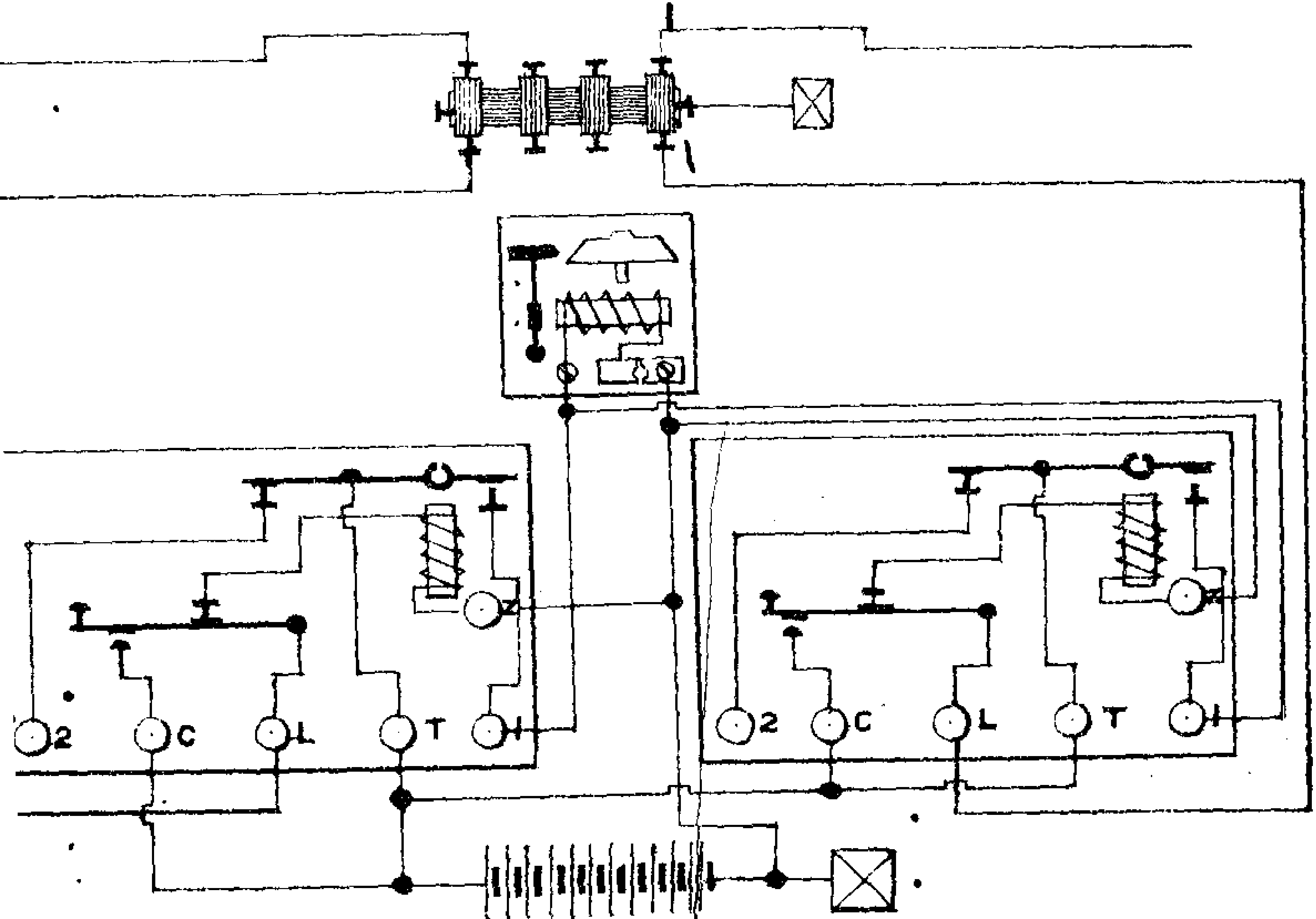


The Trembling Bell

PLATE No 13

STATE RAILWAY DOUGLAS SOUNDER

Open Circuit ("train" wire) Intermediate Station with Alarum.



MORSE INSTRUMENT

Closed Through Circuit.

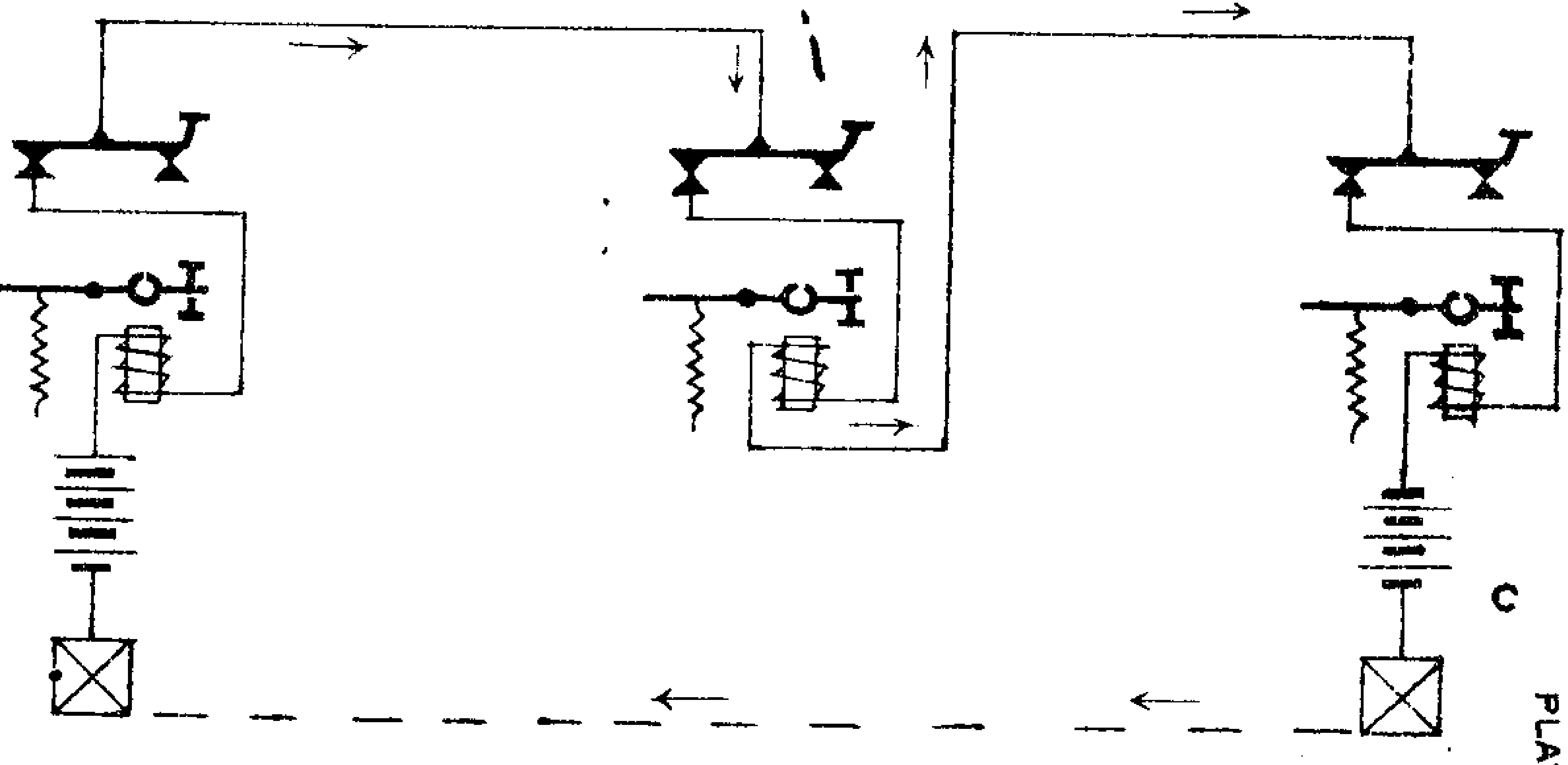
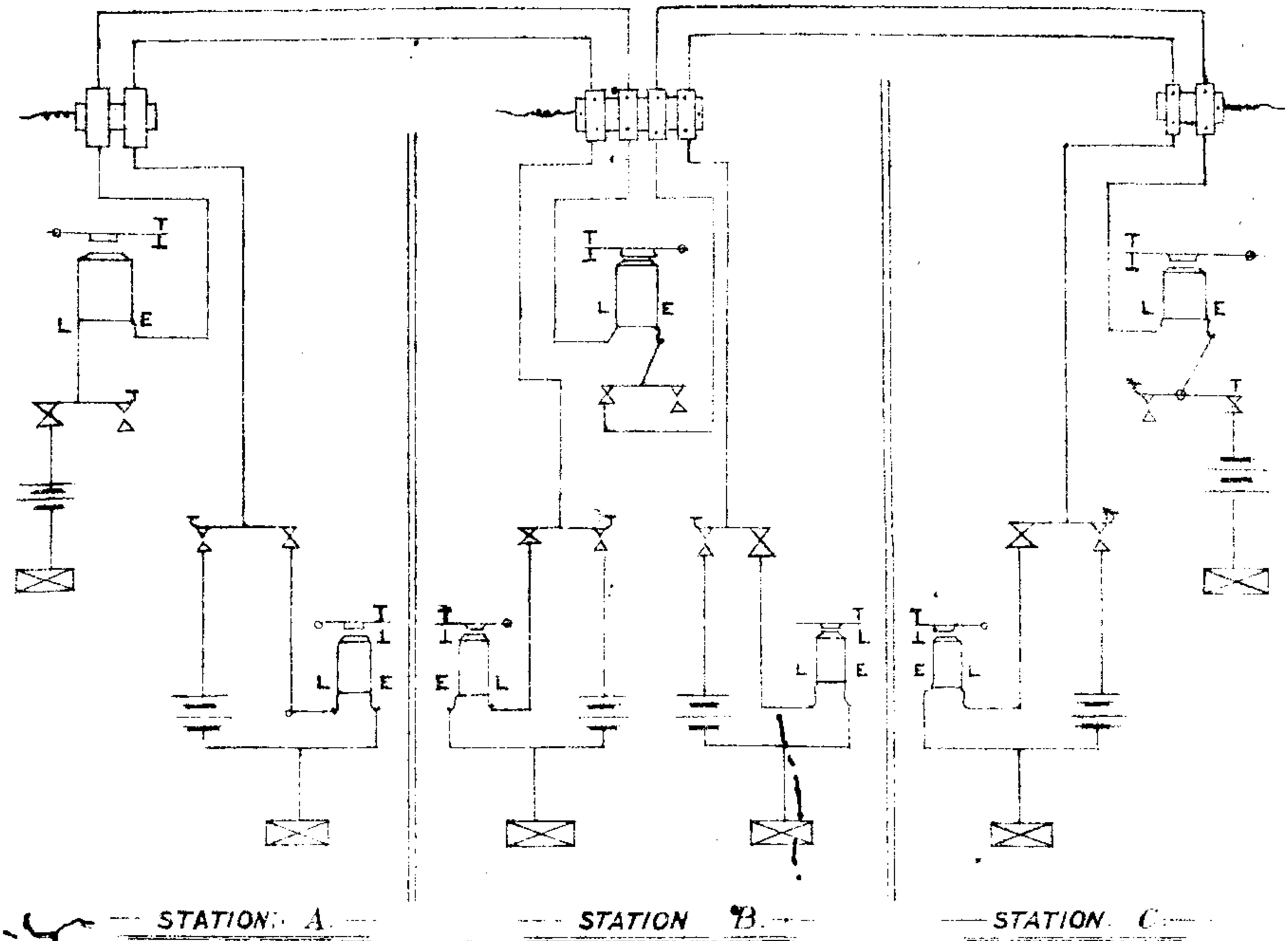


PLATE No 14

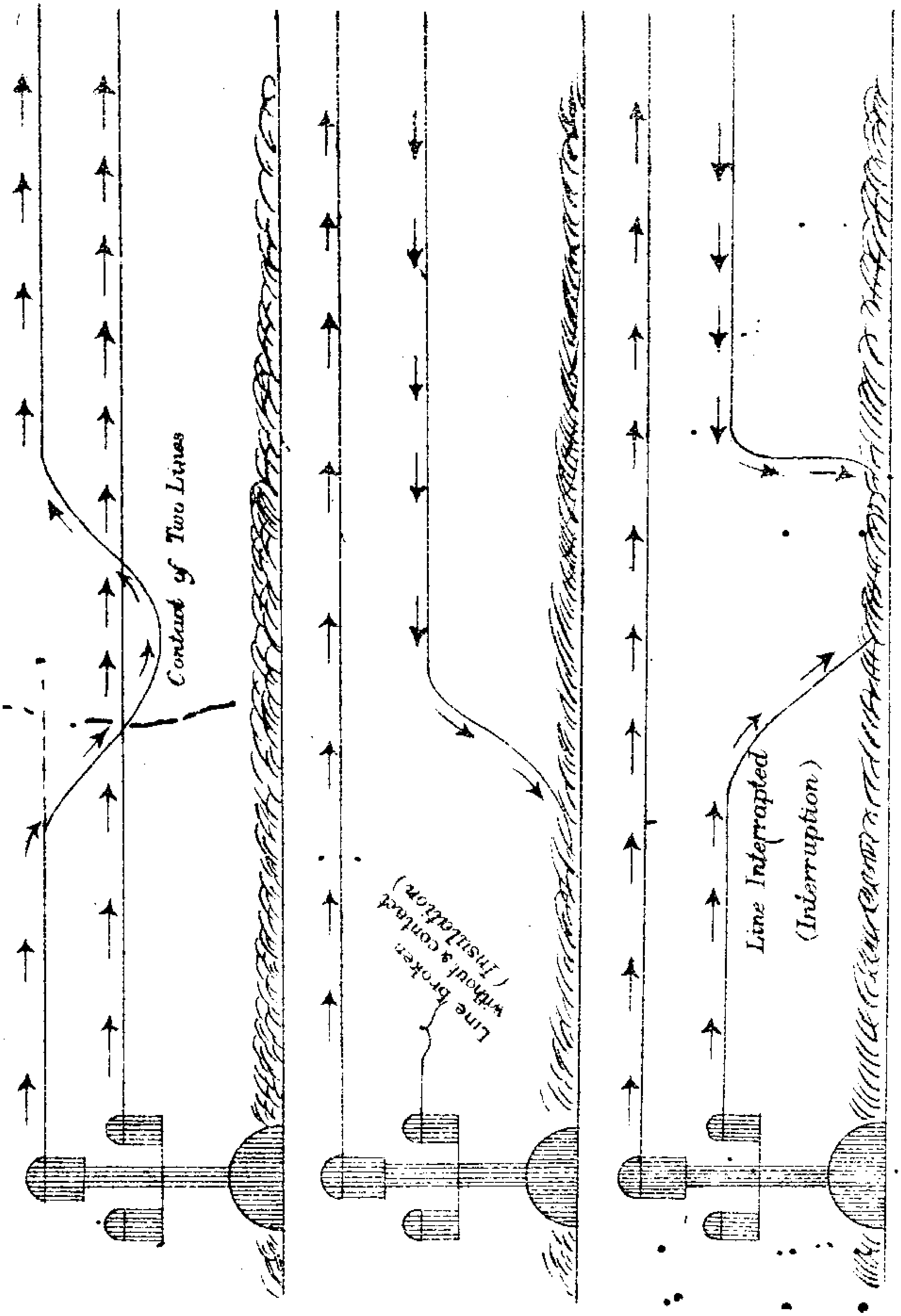
Plate No 15



Three Stations in open & closed Circuits

JAN. 19

PLATE No 18


Contact of Two Lines
Line broken without a contact (Insulation)
Line Interrupted (Interruption)

Shewing Contact Insulation & Interruption